

#### IV. CRAWFISHES OF THE SOUTHERN APPALACHIANS AND THE CUMBERLAND PLATEAU.

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As I have pointed out repeatedly (Ortmann, '05b, chiefly pp. 124, *et seq.*, and '13, chiefly pp. 381, *et seq.*), the crawfishes of the genus *Cambarus* offer in their geographical distribution many points of exceptional interest, which may be used in the study of the development of our drainage-systems and their faunas.

But the first requirement for such studies is a full knowledge of the taxonomic and chorological facts. In the region here discussed, information hitherto has been very fragmentary, but I have been able to considerably add to it through field-work done in more than the last ten years. The present paper is written for the purpose of presenting the facts thus ascertained, and to prepare the way for, and to contribute to, a final study of the zoögeographical problems.

The region covered is not very well defined. Generally speaking it forms the continuation of the area discussed in a previous paper (Ortmann, '13), lying to the south and west of it, *i. e.* covering the southern Appalachians south of Virginia and the Cumberland Plateau in the west. Yet attention to the region formerly treated cannot be avoided, for its crawfish-fauna is closely connected. The Piedmont Plateau at the eastern foot of the mountains has also been partially included. The main portion covered by the present study extends over the high Mountains in North Carolina and eastern Tennessee, the Great Allegheny Valley and the Allegheny Mountains in eastern

\*The paper here printed was in the hands of the author at the time of his sudden and lamented death on January 3, 1927. He had informed the Editor that it was ready for publication and had promised to shortly submit it to him. The manuscript, however, had been so placed by the author that it was only discovered with difficulty among a mass of notes and papers with which his desk was filled. It was some time after his death that it was discovered. It is now posthumously published in the *Annals*. It may be proper to add at this point that there were numerous other subjects which Dr. Ortmann was engaged in studying and that, had he lived, there is no doubt he would have added many other papers to the long list of important contributions, which he made to science during his industrious life of research.

Tennessee, south to northern Georgia, and the Cumberland Plateau in Kentucky and Tennessee as far south as northern Alabama. The western limit is formed by the old shore of the Mississippi Embayment (roughly marked by the northward flowing Tennessee River in western Tennessee). In a northwesterly direction, the Ohio River forms the boundary.

In this region, three subgenera of the genus *Cambarus* are represented: *Ortmannicus*, *Faxonius*, and *Cambarus sens. strict.*

### Genus CAMBARUS Erichson (1846).

*Cambarus* (subgen.) ERICHSON, '46, p. 88.

*Cambarus* (genus) GIRARD, '52, p. 87.

*Type: Astacus bartoni* Fabricius (Designated by Faxon, '98 p. 644).

*A. bartoni* having been designated as the type of the genus, the subgeneric name *Cambarus* belongs to that group which contains this species. This is *Bartoni* of Ortmann, which thus becomes a synonym of *Cambarus*. For the subgenus *Cambarus* Ortmann, a new name has been introduced, *Ortmannicus*. These nomenclatorial facts and consequent changes were first indicated by Fowler ('12 pp. 340, 341), and his views should be accepted.

### Subgenus ORTMANNICUS Fowler (1912).

*Cambarus* (subgen.) ORTMANN, '05b, pp. 96, 97. (Type: *Astacus blandingi* HARLAN).

*Ortmannicus* FOWLER, '12, pp. 340, 341. (Type: *Astacus blandingi* HARLAN).

Characterized by the gonopods of the ♂, in which the outer and inner part are in close contact up to their tips. The tips are more or less blunt, the outer one with one to three horny accessory spines or tubercles. Male with hooks on third, or (mostly) on third and fourth peræopods.

This subgenus belongs largely to the coastal plains of the southern United States. Only one species has been reported from our region.

### *Cambarus* (*Ortmannicus*) *blandingi acutus* (Girard) (1852).

*Cambarus acutus* HAGEN, '70, p. 35, Pl. I, figs. 1-5; Pl. II, figs. 106-127; Pl. III, fig. 143.

*Cambarus blandingi acuta* FAXON, '85a, p. 20.

The main species (*Cambarus blandingi* (Harlan) (1830)) is found

on the Atlantic Coastal Plain from New Jersey to South Carolina<sup>1</sup>, the variety (*acutus*) from South Carolina over the Gulf Coastal Plain to Texas, and up the Mississippi Valley (and west of it) to Illinois, Indiana, Iowa, Wisconsin, and Michigan. Both are forms living in the still water of lakes, ponds, and sluggish streams, often (probably only at certain seasons) as chimney-builders, in holes. *C. blandingi acutus* has been reported from the lowlands of Alabama<sup>2</sup> and Mississippi, and from the Mississippi bottoms at Memphis, Shelby Co., Tennessee. I found it (Aug., '24) in the Reelfoot Lake Bottoms at Walnut Log, Obion Co., Tennessee, associated with *C. clarki* Girard. In northern Alabama it has invaded our region, and is known from places in the upper Alabama and Tennessee drainages, as follows: Blount Springs, Blount Co., Alabama (Faxon) (Black Warrior drainage); Cullman, Cullman Co., Alabama (Faxon) (Black Warrior drainage); Decatur, Morgan Co., Alabama (Faxon) (Tennessee drainage); Pond formed by overflow of Tennessee River, Bridgeport, Jackson Co., Alabama (Faxon).

These localities clearly indicate the route of migration from the Alabama (Black Warrior) drainage into that of the Tennessee. The species undoubtedly is in our region an immigrant from the southern Coastal Plain. How it was able to cross over the divide remains to be investigated.

#### Subgenus FAXONIUS Ortmann (1905).

*Faxonius* ORTMANN, '05, pp. 97 and 107 (Type: *Astacus limosus* Rafinesque).

Outer and inner tips of gonopods of male distinctly separated for a shorter or longer distance, outer part, in the male I, entirely transformed into a horny spine without accessory spines. Tips straight, divergent, or nearly parallel, or gently curved (not sharply curved at nearly a right angle). Male rarely with hooks on third and fourth peræopods, generally only on the third peræopod.

I have divided ('05b, pp. 108, 109) this subgenus into three sections, represented by *limosus*, *propinquus*, and *virilis*. Their chief differ-

<sup>1</sup>Faxon ('90, p. 619) records it from North River, Lexington, Rockbridge Co., Virginia, which is within the Allegheny Mountains. There is not the slightest doubt but that this record should be discredited, the ecological conditions being entirely adverse to the presence of the species in these parts.

<sup>2</sup>On the Gulf coast at Mobile, Mobile Co., (Hagen), and Montgomery, Montgomery Co., (Faxon), in the central part of the state. To this I am able to add the following locality: Holt's Ditch, Barachias, Montgomery Co., Alabama. (1 ♂, 3 ♀, Olivia Holt, April 12, '25).

ences are in the gonopods. In the *limosus*-section, their tips are separated only for a short distance; in the *propinquus*-section, they are separated for a greater distance, and mainly straight; in the *virilis*-section, they are also separated for a greater distance, but both are distinctly, although gently, curved.

All three sections are represented in our region, but the first one only by a single and very peculiar species.

#### SECTION OF *C. LIMOSUS*.

Gonopods of male short, rather thick up to near the tips, reaching to the coxopodites of the third peræopod. Tips separated for a short distance only, each tapering to a point. Males with hooks on third, or on third and fourth peræopods.

Undoubtedly a primitive group, forming a sort of connection between the more primitive species of the subgenus *Ortmannicus* and the more advanced forms of *Faxonius*.

The typical species of this section (*harrisoni*, *sloanei*, *indianensis*, and *limosus*) are not found in our region<sup>3</sup>, but belong to the interior Basin; the first three to the Mississippi and lower Ohio drainages, the last one to the northern part of the Atlantic Coastal Plain. One very peculiar cave-species, however, is found on the Cumberland Plateau in Kentucky, the famous Blind Cave-crawfish of Mammoth Cave.

#### ***Cambarus (Faxonius) pellucidus* (Tellkamp) (1844).**

HAGEN, '70, p. 55, Pl. I, figs. 68-71; Pl. 3, fig. 148; Pl. 6;—Faxon, '85a, p. 40;—Hay, '96, p. 482, fig. 3;—Hay, '02a, p. 230;—Call in Hovey, '12, p. 109, fig. opp. p. 119.

With rudimentary eyes; carapace subcylindrical; chelæ subcylindrical. Male with hooks on third and fourth peræopods.

*Type locality*: Mammoth Cave, Edmonson Co., Kentucky. (Tellkamp) (Hagen) (Faxon) (Hay) (Call).

White cave, and other caves, Edmonson Co., Kentucky (Faxon).

In caves in Jefferson, Harrison, Crawford, Orange, Lawrence, and Bartholomew Cos., in southern Indiana (Cope) (Faxon) (Hay); and a variety, *C. pellucidus testi* Hay (1893) in Monroe Co., Indiana.

The range of this species is now cut in two by the Ohio River. It is morphologically and geographically a rather isolated species. Yet in the northern part of its range (in southern Indiana) there are two

<sup>3</sup>*C. sloanei* has been reported from Kentucky by Bundy, but this requires confirmation.

species found in surface waters (*C. sloanei* Bundy and *C. indianensis* Hay), which also belong to the *limosus*-section. The former (*C. sloanei*) is known from about the same parts in Indiana (Jefferson, Floyd, Crawford, and Orange Cos.), and also has been reported from Kentucky (by Bundy, without exact locality). The other (*C. indianensis*) is found a little more to the west, in Dubois and Gibson Cos., in southwestern Indiana (drainage of Patoka River to Wabash). The Carnegie Museum possesses specimens of *C. indianensis* from South Fork Saline River, Saline Co., Illinois (tributary to Ohio, below Wabash, in southeastern part of state).

These two are the species most closely allied to *C. pellucidus*, yet they are sharply distinct from it. They probably are the last remnants of the surface-stock from which *C. pellucidus* descended.

#### SECTION OF *C. PROPINQUUS*.

Gonopods of male shorter or longer, not thick, deeply split at the tips, tips slender, more or less straight, sometimes the outer one slightly recurved towards the end, but never both tips curved in the same direction. In the male, always the third peræopods with hooks (barring freaks).

This section is abundantly represented in our region, chiefly in the rivers of the Cumberland Plateau. It mainly contains typical river-forms, which in part are very variable and hard to distinguish. The following key will be useful for their distinction.

##### 1. Group: (*propinquus*).

Tips of the gonopods of the ♂ I comparatively short, reaching only to the coxopodites of the third, rarely (in *erichsonianus*) to that of the second peræopods, with or without shoulder on the anterior margin. Outer tip not setiform, but regularly tapering from the thicker base to the end. The inner tip as long as, or very little shorter, than the outer.

a. Gonopods reaching to the third peræopods only, in the ♂ I with or without shoulder, (extralimital forms: *propinquus*, *sanborni*, *obscurus*, of which only *sanborni* approaches the region under discussion; in West Virginia and eastern Kentucky).

a'. Gonopods reaching to the second peræopods, in the ♂ I without shoulder.

*C. erichsonianus*.

##### 2. Group: (*rusticus*).

Tips of gonopods of the ♂ I longer, reaching to the coxopodites of the second or first peræopods. Outer tip setiform, very little thicker

at the base; inner tip distinctly falling short of the outer, also in the ♂ II.

- a. Gonopods reaching to the coxopodites of the second peræopods (with or without shoulder). Rostrum with margins elevated and thickened, concave, curved outward at base..... *C. rusticus*.
- b. Gonopods of ♂I without shoulder, outer tip slightly recurved at end. Rostrum narrower, with long acumen, often with a slight median carina. Fingers of chelæ in adult males widely gaping, long, more or less subcylindrical.
- c. Areola as long as, or slightly shorter, than one-third of the carapace, rather wide. Whole hand comparatively short and broad.  
*C. rusticus forceps*.
- c'. Areola as long as, or slightly longer, than one-third of the carapace, narrower. Whole hand comparatively long and slender.  
*C. rusticus placidus*.
- b'. Gonopods of ♂I with shoulder; outer tip slightly recurved or straight. Rostrum mostly somewhat wider, with shorter acumen, sometimes with a slight median carina. Fingers of chelæ in adult males only slightly gaping, not very long, not subcylindrical, but rather compressed.
- c. Areola wide and short, shorter than one-third of the carapace. Lateral spines of carapace small or absent. Tubercles on hand and fingers very weak, obliterated. Outer tip of gonopods gently curved at end.  
*C. rusticus mirus*.
- c'. Areola narrower and longer, longer than one-third of the carapace. Lateral spines of carapace generally present, but sometimes small. Tubercles of hand and fingers present, forming two distinct rows on inner margin of palm. Outer tip of gonopods curved or straight.  
*C. rusticus rusticus*.
- a'. Gonopods reaching at least to the posterior margins of coxopodites of first peræopods, with shoulder in ♂I. Rostrum with the margins straight, subparallel (or slightly convergent anteriorly), not thickened..... *C. juvenilis*.

### **Cambarus (Faxonius) propinquus** Girard (1852).

ORTMANN, '06, p. 358, Pl. 39, fig. 6a, 6b.

This species is of northern distribution. It has been found from Iowa, through Illinois and Indiana to Ohio in the interior drainage; and northward in the lake-drainage from Wisconsin to New York; and in Ontario and Quebec in Canada. It is not positively known from south of the Ohio River. There is one record given by Hay ('02a, p. 235) from Green River, Mammoth Cave, Kentucky. Since this is based upon "a few small specimens which *appear* to belong to this species," I seriously question the correctness of the identification. The characteristic species of Green River is *C. juvenilis*.

**Cambarus (Faxonius) propinquus sanborni** (Faxon) (1884).

ORTMANN, '06, p. 365.

This form exists in the Ohio-drainage of West Virginia (Ohio, Guyandot, Kanawha, and Little Kanawha) and of Ohio (Scioto, Muskingum), and crosses over into the Lake Erie drainage (Cuyahoga to Vermillion Rivers). The type-locality is Smoky Creek, Carter Co., Kentucky (Faxon). I have not been able to locate a creek of this name in Carter Co., (northeast Kentucky), but there is here a place called "Smoky Valley." This belongs to the drainage of Tygart Creek, a tributary to the Ohio just above the mouth of Scioto River (on the Ohio side). If the assumption is correct, that *C. propinquus sanborni* is found here, it should exist also in the drainage of Big Sandy River (forming the boundary of Kentucky and West Virginia), and this, indeed, is fully supported by Faxon's report ('14, p. 374) from Horse Creek, West Virginia. This is a small tributary of Tug Fork, Big Sandy, about three miles above Panther, McDowell Co.<sup>4</sup> Farther up in the Big Sandy drainage, in tributaries of Dry Fork in McDowell Co., *C. juvenilis* is found (which see). Going up in the Ohio drainage from the Big Sandy, *C. propinquus sanborni* is present in the next important affluent, Guyandot River. I found it myself in a tributary of this, Mud River, Milton, Cabell Co., West Virginia. Thence further on, in Big and Little Kanawha, this form is common, and it is also in the Ohio proper in this section.<sup>5</sup>

Thus *C. propinquus sanborni* just touches the northern part of our section, coming here in the Big Sandy drainage in contact with *C. juvenilis*, which is characteristic of the more western rivers in Kentucky (Licking, Kentucky, Green), and which passes southward into the drainages of the upper Cumberland and Tennessee (see below, under *juvenilis*).

**Cambarus (Faxonius) erichsonianus** Faxon (1898).

*C. erichsonianus* FAXON, '98, p. 659; Pl. 64, figs. 7-12;—HAY, '99, pp. 960, 964;—

HARRIS, '03, p. 96;—FAXON, '14, p. 418.

*C. spinosus* HAY (not BUNDY), '02b, p. 439.

*C. (Faxonius) erichsonianus* ORTMANN, '05b, p. 112.

*C. spinosus gulielmi* FAXON, '14, pp. 375, 419.

<sup>4</sup>See Topographic Atlas (Sheet, Iaeger) West Virginia.

<sup>5</sup>See Ortmann, '13, p. 334. A new locality in this region is to be added: Pocatalico River, Raymond City, Putnam Co., West Virginia (1 ♂II, May 9, '13) (To Big Kanawha).

*Type-locality*: "Rip Roaring Fork, five miles northwest of Greeneville, Tennessee." (Faxon). According to the Topographic Atlas, (Sheet Greeneville), this should be given as follows: Roaring Fork, Greeneville, Greene Co., Tennessee, (tributary to Lick Creek and Nolichucky River).

KNOWN LOCALITIES FOR *C. ERICHSONIANUS*:

**Tennessee drainage, below Walden Gorge.<sup>6</sup>**

Small run tributary to Elk River, Fayetteville, Lincoln Co., Tennessee. (3 ♂♂ II, 2 ♀♀, Aug. 23, '23).

**Tennessee drainage above Walden Gorge, and below Knoxville.**

Stream from John Ross Spring, Rossville, Walker Co., Georgia. (Type locality of *C. gulielmi* (Faxon) to Chattanooga Creek and Tennessee River).

South Chickamauga Creek, Ringgold, Catoosa Co., Georgia. (1 ♂ II, 2 ♀♀, May 20, '15).

Hiawassee River, Austral, Polk Co., Tennessee. (1 ♂ II, Sept. 19, '15).

Eastanaula<sup>7</sup> Creek, Athens, McMinn Co., Tennessee. (Faxon) (to Hiawassee).

Matlock Spring Creek, Athens, McMinn Co., Tennessee. (Faxon) (not located on map, but in the same vicinity as the last locality).

Piney River, Spring City, Rhea Co., Tennessee. (2 ♂♂ II, 1 ♀, May 18, '15) (tributary to Tennessee from Walden Ridge).

Tennessee River, Concord, Knox Co., Tennessee. (2 ♀♀, Sept. 9, '14).

Clinch River, Black Fox Ford, Union Co., Tennessee. (1 ♀, Sept. 15, '15).

Clinch River, Clinch River Station, Claiborne Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 11, '13).

Cove Creek, Caryville, Campbell Co., Tennessee. (1 ♀, Sept. 12, '15) (to Clinch).

Powell River, Combs, Claiborne Co., Tennessee. (1 ♂ I, Sept. 13, '15).

Little River, Rockford, Blount Co., Tennessee. (1 ♂ II, Sept. 4, '14).

<sup>6</sup>The locality: "Big Cahawba River, Alabama," given by Faxon ('98) is too vague to be considered. It only serves to show that possibly the range extends farther south than the other known localities would indicate.

<sup>7</sup>Oostanaula Creek on Topographic Atlas (Sheet Cleveland) but the natives call it Eastanaula!

**French Broad drainage.**

French Broad River, Boyd Creek, Sevier Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 10, '14).

Little Pigeon River, Sevierville, Sevier Co., Tennessee. (1 ♂ II, Aug. 31, '14).

Nolichucky River, Chunn's Shoals, Hamblen Co., Tennessee. (1 ♂ I, Sept. 17, '13).

Nolichucky River, Chuckey, Greene Co., Tennessee. (1 ♀, May 19, '14).

Whitehorn Creek, Bulls Gap, Hawkins Co., Tennessee. (1 ♂ II, 1 ♀, May 18, '14) (to Nolichucky).

Roaring Fork, Greeneville, Greene Co., Tennessee. (Faxon, type-locality) (to Lick Creek and Nolichucky).

**Holston drainage.**

Holston River, Mascot, Knox Co., Tennessee. (2 ♀ ♀, Sept. 6, '14).

Big Flat Creek, Corryton, Knox Co., Tennessee. (1 ♂ I, May 12, '14) (to Holston).

**SUMMARY OF DISTRIBUTION.**

The metropolis of this species apparently is in the Tennessee River, proper, and its tributaries above Walden Gorge, chiefly in the Hiawassee and French Broad in the Great Valley. In the Clinch and Holston it has been found only in the lower parts, and is absent in the headwaters of these. It is also in the Tennessee drainage below the Gorge, but so far only in a tributary to Elk River. It may be widely distributed in the latter region.

It is found in large rivers and in creeks<sup>8</sup>, sometimes in rather small ones (Fayetteville, Whitehorn Creek, Big Flat Creek), living in the usual way of river-species, under rocks, etc. Males of the I form have been found in the months of September and May.

**TAXONOMIC REMARKS.**

The essential characters of this species are found in the gonopods of the male, which are straight, and reach the coxopodites of the second peræopods (their posterior end or a little beyond), with the branches *nearly* of equal length<sup>8</sup>). This condition is not found in any other *Faxonius*-form of the same regions. In the *rusticus*-group,

<sup>8</sup>In the male I from Combs (Powell River), the outer tip is a little longer than the inner, but, for the rest, this organ is like that of *erichsonianus*, *i. e.* the outer tip is not setiform, and there is no shoulder.

where these organs have about the same length, the two branches are distinctly unequal, the outer being the longer.

In addition, in the male of the I form, the outer (horny) branch tapers gradually, as in the *propinquus*-group, and is not setiform, as in the *rusticus*-group. Finally there is no shoulder in *erichsonianus*.

For the rest, this species has no prominent or peculiar characters, so that females, without males, are very hard to identify. The female annulus ventralis is less sculptured than in the *rusticus*-group, yet it has two weak tubercles in front, and the posterior border also has a tubercle, which, in old females, may be even higher than the anterior ones. The median transverse furrow is shallow. In the shape of the annulus, *erichsonianus* differs from *juvenilis*, which in other respects is very similar. *Juvenilis* also has the anterior tubercles very strong, separated by a narrow cleft, and partly overhang the narrow and deep transverse fossa.

The rostrum of *erichsonianus* has nearly parallel, or somewhat convergent straight margins, which are not thickened. In the *rusticus*-group, the margins generally are somewhat concave and thickened. The acumen is well developed, also the marginal spines. The upper surface is gently concave, without a keel. The areola is moderately narrow, about as long as half of the anterior section of the carapace, sometimes a little shorter, rarely a little longer. The chelæ are of the general shape of those of other species of the *propinquus*-section, broad, slightly inflated, the fingers somewhat longer than the palm, a little gaping at the base in older specimens, chiefly old males, but meeting all along their margins in young specimens. The inner margin of the palm has a double row of distinct tubercles. The dactylopodite also has several rows of tubercles on the outer margin, and both fingers have longitudinal ribs.

Faxon gives for a male I the length of 70 mm. I have a male I (Corryton), 91 mm. long, and a female (Bulls Gap) of 84 mm.

*C. spinosus gulielmi* Faxon ('14) is founded upon the identical specimens called *C. spinosus* by Hay ('02), which are represented only by males of the II form, and females. It is undoubtedly this species, and it is rather strange, that Faxon did not recognize his own species. *C. spinosus* (= *putnami* = *juvenilis*, see below) differs essentially from *erichsonianus*, as well as from other forms of the *rusticus*-group, in the length of the gonopods, which reach to the coxopodites of the first peræopods. Faxon expressly states, under *gulielmi*, that the gonopods

are not of this type, and thus there is no reason whatever to connect *gulielmi* with *spinosus* (or *juvenilis*). In fact, the description of the gonopods, as well as the rest of the description of *gulielmi*, applies word for word to *erichsonianus*, with the exception, that Faxon emphasizes the presence of hairs on the carapace and chelæ, a character, of which he admits, however, that it "may be evanescent." This undoubtedly is correct. Moreover, I have found *erichsonianus* not very far from the type-locality of *gulielmi* (Rossville, Georgia) in Chickamauga Creek at Ringgold, Georgia.

***Cambarus (Faxonius) rusticus* Girard (1852).**

GENERAL REMARKS.

I unite under *rusticus*, in a wider sense, several forms, which hitherto have been regarded as distinct species (*rusticus* and *forceps*), and, on the other hand, I distinguish under it several additional forms, which have not been properly recognized. The Cumberland-Tennessee drainages in the Great Allegheny Valley and the Cumberland Plateau seem to form the metropolis of this assemblage. Possibly this is its center of origin, whence it spread into the lower Ohio and the Interior Basin where it is represented chiefly by the typical form of *rusticus*. In the Cumberland and Tennessee are other forms, closely allied to *rusticus*, which I regard now as local races or varieties of it. These are *C. forceps* of the Tennessee drainage, *C. placidus*, chiefly of Cumberland and Duck Rivers, and a very peculiar new form, *C. rusticus mirus*, from the headwaters of Elk and Duck Rivers.

There is no question that *forceps* and *placidus* are more primitive than the true *rusticus*, as far as it concerns the shape of areola and gonopods. In the chelæ, however, they show a somewhat higher differentiation. *C. rusticus mirus* is even more primitive than these in the areola, and also has rather primitive chelæ, like typical *rusticus*. The latter appears as the most advanced form, although the chelæ are not so much specialized as in *forceps* and *placidus*.

The oldest name for all these forms is *rusticus*. The others, then, should be made varieties of it. *C. forceps* and *placidus* stand very near to each other. The differential characters of the areola and hand pass into each other, those of the hand not being well marked in young specimens. *C. placidus* is connected with typical *rusticus* by a form found in the Cumberland and Duck drainages which I call *rusticus*, but which inclines, in several particulars (gonopods and occasional

presence of keel on rostrum), toward *placidus*. *C. mirus* is practically the same as the Cumberland-Duck *rusticus*, except for the shorter areola, and an inclination of the rostrum toward the *placidus-forceps*-type. In the areola it is closest to *forceps* and more primitive than any other member of the group. In the frequently missing lateral spine of the carapace it resembles typical *rusticus* in which the spine is often small or obsolete, thus indicating again the most advanced phase of the whole group in this respect.

We see in this assemblage of forms that peculiar arrangement of characters often observed in other groups of closely allied forms: there are certain varying characters, some of which may show more primitive or more advanced stages (gonopods, areola, spinosity). In each of the various forms these features are irregularly mixed, each exhibiting different combinations, so that it is hard or impossible to point out a single form which is *the* most primitive. This, I think, has been brought out by what has been said in the preceding paragraph. The arrangement selected here takes account chiefly of the gonopods and areola where primitive and advanced phases are most easily recognized. Thus the sequence, *forceps-placidus-mirus-rusticus*, expresses to a degree the advance in specialisation. It must not be forgotten, however, that for other characters (chelæ for instance) this sequence does not hold good.

The common characters of all these forms, by which they differ from *erichsonianus* and *juvenilis*, are found in the gonopods which reach to the coxopodites of the second peræopods. These are deeply split, with the outer branch being setiform and distinctly longer than the inner, and rather straight, but sometimes gently recurved at the tip. The rostrum also is of a common type. It has the margins elevated and somewhat thickened, concave, and not straight. This is seen chiefly near the base of the rostrum where the margins diverge and curve outward. In *erichsonianus* and *juvenilis*, however, the posterior ends of the margins, although sometimes slightly divergent, do not *curve* outward, but are straight, continuing in the same direction as the rest of the margins.

***Cambarus (Faxonius) rusticus forceps* (Faxon) (1884).**

- C. forceps* FAXON, '84, p. 133;—FAXON, '85a, p. 119, Pl. 5, fig. 4; Pl. 9, fig. 5;—FAXON, '85b, p. 461;—UNDERWOOD, '86, p. 369;—FAXON, '90, p. 633;—FAXON, '98, p. 660;—HAY, '99, pp. 960, 964;—HARRIS, '03, p. 98;—FAXON, '14, p. 418.  
*C. (Faxonius) forceps* ORTMANN, '05b, p. 112.

*Type-locality:* Cypress Creek, Lauderdale Co., Alabama. (Faxon) (tributary to the Tennessee River at Florence).

KNOWN LOCALITIES.

**Tennessee drainage below Walden Gorge.**

Cypress Creek, Lauderdale Co., Alabama. (Faxon, type-locality).  
Cypress Creek, Florence, Lauderdale Co., Alabama. (5 ♂♂ II, 3 ♀♀, Aug. 24, '24) (Topotypes).  
Shoals Creek, Bailey Springs, Lauderdale Co., Alabama. (1♀, Aug. 25, '24).

**Tennessee drainage above Walden Gorge.**

Tennessee River, Concord, Knox Co., Tennessee. (1 ♂ I, 4 ♂♂ II, Sept. 9, '14).  
Piney River, Spring City, Rhea Co., Tennessee. (4 ♂♂ II, 1♀, May 18, '15).  
Clinch River, Walker's Ford, Claiborne Co., Tennessee. (Faxon).<sup>9</sup>  
Clinch River, Clinch River Station, Claiborne Co., Tennessee. (2 ♂♂ II, Sept. 11, '13).  
Clinch River, Fink, Russell Co., Virginia. (1 ♂ I, May 12, '13).  
Cove Creek, Caryville, Campbell Co., Tennessee. (1 ♂ I, 2 ♂♂ II, 2♀♀, Sept. 12, '15) (to Clinch).  
Powell River, Dryden, Lee Co., Virginia. (1♀, Sept. 7, '13).  
South Fork Powell River, Big Stone Gap, Wise Co., Virginia. (1 ♂ I, 1 ♂ II, 1♀, May 15, '13 and 6 ♂♂ I, Sept. 6, '13).  
Ball Creek, south of Tazewell, Claiborne Co., Tennessee. (Faxon).<sup>10</sup>  
Dutch Valley Creek, Oakman, Grainger Co., Tennessee. (1 ♂ II, 1♀, Sept. 14, '15) (to Clinch).  
Pistol Creek, Rockford, Blount Co., Tennessee. (1 ♂ I, 4 ♂♂ II, 3♀♀, Sept. 4, '14) (to Little River).  
Brook at Knoxville, Knox Co., Tennessee. (Faxon).  
Holston River, McMillan, Knox Co., Tennessee. (2 ♂♂ II, 1♀, Sept. 16, '13).  
Holston River, Mascot, Knox Co., Tennessee. (2♀♀, Sept. 6, '14).  
South Fork Holston River, Pactolus, Sullivan Co., Tennessee. (1 ♂ II, May 20, '14).  
South Fork Holston River, Barron, Washington Co., Virginia. (2♀♀, May 19, '13).  
Middle Fork Holston River, Glade Springs, Washington Co., Virginia. (Faxon).

<sup>9</sup>Given as northwest of Tazewell, but is southwest of this place.

<sup>10</sup>Given as "Bulls Creek," but it is Ball Creek, going to Big Sycamore Creek and Clinch River, see: Topographic Atlas (Sheet Maynardville).

- Middle Fork Holston River, Chilhowie, Smyth Co., Virginia. (1 ♂ II, May 20, '13).  
 French Broad River, Boyd Creek, Sevier Co., Tennessee. (1 ♂ II, Sept. 10, '14).  
 Little Pigeon River, Sevierville, Sevier Co., Tennessee. (1 ♀, Aug. 31, '14).  
 Nolichucky River, Chunn's Shoals, Hamblen Co., Tennessee. (1 ♂ II, Sept. 17, '13).  
 Nolichucky River, Erwin, Unicoi Co., Tennessee. (1 ♂ II, May 17, '14).  
 Bent Creek, Whitesburg, Hamblen Co., Tennessee. (2 ♂ ♂ I, 3 ♂ ♂ II, 5 ♀ ♀, Sept. 8, '15) (to Nolichucky).  
 Whitehorn Creek, Bulls Gap, Hawkins Co., Tennessee. (9 ♂ ♂ II, 2 ♀ ♀, May 18, '14) (to Bent Creek and Nolichucky).

#### SUMMARY OF DISTRIBUTION.

This form belongs to the Tennessee drainage, both below and above Walden Gorge. Below the Gorge, it is known only from the type-locality in Cypress Creek, and from Shoals Creek, not far from it. Above the Gorge it is in the Tennessee proper and its tributaries, Clinch, Holston, and French Broad, chiefly in the headwaters, going up into rather small streams, and being abundant there. It is a river-form, living in the usual way under stones, etc.

Males of the I form have been found in the months of May and September. A female with young was taken on May 15, '13 (Big Stone Gap).

#### TAXONOMIC REMARKS.

This form may be recognized chiefly by the absence of a shoulder on the gonopods, by the areola, which is slightly wider and shorter than in *placidus* (although there is very little difference), and by the peculiar conformation of the hand of the adult male.

The areola of *forceps* is 30 to 36 per cent of the length of the carapace (in *placidus*, 32 to 37 per cent), but it is, in the most cases, slightly shorter than one-third (less than 33 per cent), while in *placidus* it is usually slightly longer. It is a little wider, having room for from four to six rows of dots in its narrowest part (while *placidus* has two to four rows).

The fingers of the hand, in old males, are long, and the moveable finger is about two and one-half times as long as the inner margin of the palm. The fingers are not of the usual shape (compressed and tapering), but are subcylindrical, widely gaping at the base, and meet-

ing only near the tips. This gap is two, and even three times as wide as the width of each finger. The whole hand of *forceps* is rather broad, and comparatively shorter than in *placidus*, rarely two and one-half times as long as wide (the length being measured from the proximal end of the outer margin of the propodite). It is generally shorter, sometimes hardly longer than twice as long as wide (chiefly so in females and young individuals). In consequence of this, the old males have the anterior margin of the palm (between the fingers) transverse, running at about a right angle to the outer margin (see Faxon's figure, Pl. 5, fig. 4). In *placidus* this part is oblique.

*Forceps* and *placidus* are alike in the rostrum, the spines of the carapace, and in the shape of the gonopods. The rostrum is comparatively long and narrow with rather long acumen, and with the tip of the latter, and the marginal spines, more or less upturned. The upper surface is strongly concave, often (but not always) with a median carina. (In typical *rusticus*, the rostrum is broader, with shorter acumen, not so greatly concave, and rarely with a trace of a carina). The lateral spines of the carpace are generally well developed. The branchiostegal spine is obsolete, and the extraorbital angle is bluntly angular or rounded. In the males of both of the I and II forms of *forceps* and *placidus* the gonopods have the outer tip gently recurved at the end.

Of the spines of the carpopodite of the first peræopods, the median one on the internal margin, and the external one, are more or less developed. The inferior median spine of *forceps*, however, is generally absent, and this is an additional difference from *placidus*, where the latter spine is rarely obsolete.

Faxon seems to lay much stress on the presence or absence of a beard on the inner base of the immoveable finger of the hand. The general rule in all forms belonging to *rusticus* is that a beard is more or less developed in all young specimens and in females, while it is absent in old males of the I form. There are exceptions to this, and in typical *rusticus* this beard is mostly poor or absent. Traces of it may be seen sometimes in old males of *forceps*, and it may even be well developed.

I have collected topotypes of this form at Florence, Alabama, mostly young ones, but one male II, and one female are of fair size (respectively 55 and 50 mm.), and they agree very well with the specimens from the upper Tennessee.

In northern Alabama, in Shoals Creek, I have found *forceps* and

*placidus* associated, and it was very hard to separate them, especially the young ones and the females. In the case of the latter, I was largely guided by the shape of the hand, which is somewhat shorter and wider in *forceps*. In other cases the areola helped to distinguish the two forms. But there are still specimens in which the identification is somewhat doubtful. It seems that these two closely allied forms *intergrade* in this region, and thus they could not possibly be regarded as good species.

The maximum size, given by Faxon is: ♂ I 38 mm; ♀ 60 mm. My largest ♂ I (Rockford) is 64 mm. long. A ♂ II (Florence) is 55 mm. This form does not seem to grow very large.

***Cambarus (Faxonius) rusticus placidus* (Hagen) (1870).**

*C. placidus* HAGEN, '70, p. 65, Pl. 1, figs. 76 and 79; Pl. 3, fig. 158;—SMITH, '74, p. 638;—FORBES, '76, pp. 4 and 19.

*C. rusticus (pro parte)* FAXON, '84, p. 148;—FAXON, '85a, p. 108;—FAXON, '85b, p. 361;—UNDERWOOD, '86, p. 361;—HARRIS, '03, p. 121;—FAXON, '14, pp. 375 and 418.

*C. rusticus (= placidus)* FAXON, '90, p. 632;—HARRIS, '00, p. 271.

*C. (Faxonius) rusticus (pro parte)* ORTMANN, '05b, p. 112.

*Type-locality:* Lebanon, Wilson Co., Tennessee. (Hagen). (Probably in a small tributary to Cumberland River, Barton, or Spring Creeks).

KNOWN LOCALITIES.

**Cumberland drainage.<sup>11</sup>**

Harpeth River, Kingston Springs, Cheatham Co., Tennessee. (1 ♂ II, 2 ♀ ♀, Aug. 31, '21).

Harpeth River, Belleview, Davidson Co., Tennessee. (5 ♂ ♂ II, 3 ♀ ♀, Aug. 28, '21).

Harpeth River, Franklin, Williamson Co., Tennessee. (Faxon).

West Fork Stones River, Murfreesboro, Rutherford Co., Tennessee. (4 ♂ ♂ II, 1 ♀, Aug. 30, '21).

Lebanon, Wilson Co., Tennessee. (Hagen, *Type-locality*) (in Barton or Spring Creek).

Pitman Creek, Burnside, Pulaski Co., Kentucky. (1 ♂ II, 1 ♀, Sept. 1, '24).

<sup>11</sup>Possibly specimens reported by Faxon ('14, p. 375) as *rusticus* from Richland Creek, Nashville, Davidson Co., Tennessee, belong here. I cannot find a "Richland Creek" near Nashville on the Topographic Atlas (Sheet Nashville). There is a Richland Creek farther South, tributary to Elk River. This might have been the one referred to, but it is not near Nashville. This form does exist in the Elk River drainage and in that of the Tennessee in northern Alabama. See below.

**Duck River drainage.**

- Duck River, Centreville, Hickman Co., Tennessee. (3 ♂♂ II, 3 ♀♀, Aug. 29 and Sept. 4, '21).
- Duck River, Columbia, Maury Co., Tennessee. (1 ♂ II, Aug. 26, '21).
- Duck River, Shelbyville, Bedford Co., Tennessee. (2 ♂♂ II, Sept. 1, '22).
- Duck River, Manchester, Coffee Co., Tennessee. (1 ♂ II, 1 ♀, Aug. 21, '23).
- Buffalo River, Riverside, Lewis Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 7, '22).
- Big Bigby Creek, Mount Pleasant, Maury Co., Tennessee. (4 ♂♂ II, 1 ♀, Aug. 25, '21).
- Rutherford Creek, Godwin, Maury Co., Tennessee. (3 ♀♀, Sept. 6, '22).
- West Rock Creek, Lewisburg, Marshall Co., Tennessee. (2 ♂♂ I, 1 ♂ II, 2 ♀♀, Aug. 26, '23).
- Garrison Creek, Wartrace, Bedford Co., Tennessee. (2 ♂♂ II, 1 ♀, Sept. 2, '22).
- Little Duck River, Manchester, Coffee Co., Tennessee. (2 ♂♂ I, 1 ♂ II, 2 ♀♀, Aug. 21, '23).

**Tennessee drainage.**

- Tennessee River, Florence, Lauderdale Co., Alabama. (1 ♂ II, Aug. 26, '24).
- Shoals Creek, Bailey Springs, Lauderdale Co., Alabama. (1 ♂ II, 1 ♀, Aug. 25, '24).
- Rock Creek, Tullahoma, Coffee Co., Tennessee. (1 ♂ II, Aug. 18, '23) (to Elk River).

**Interior Basin.**

- Barren River, Bowling Green, Warren Co., Kentucky. (1 ♂ II, Aug. 11, '24) (to Green River).
- Quincy, Adams Co., Illinois. (Hagen).

**SUMMARY OF DISTRIBUTION.**

The home of *placidus* is mainly in tributaries of the Cumberland River, and in the Duck River drainage, but it exists also in the Tennessee drainage below Walden Gorge (vicinity of Florence, Alabama, and headwaters of Elk River). The locality Quincy, Illinois, would indicate that it extends farther north, into western Kentucky, and beyond, but this is a region where our knowledge is very defective. A form probably belonging here is known only from the Green River drainage (Barren River), it may even go beyond the Mississippi, into

Missouri (see below). However, it might be that the single individual from Quincy is not the real *placidus*, although for a long time this had to be regarded as a paratype of the form, and was the only male of the I form known.

*C. rusticus placidus* lives exactly as other river-forms, in larger or smaller rivers and creeks, under stones, etc. I found males of the I form on Aug. 21 and 26, 1923, while I was not able to find such in August and September in 1921 and 1922.

#### TAXONOMIC REMARKS.

This form stands very close to *C. rusticus forceps*, and agrees with it chiefly in the shape of the rostrum, which is rather narrow and often has a carina; in the widely gaping and subcylindrical fingers of the chelæ of the adult male; and in the shape of the gonopods. It differs, however, in the following characters: Areola slightly shorter or longer than one-third of the carapace, but *mostly* slightly longer, narrower, with two to four rows of dots in the narrowest part (*forceps* has four to six rows). The three spines of the carpopodite of the first peræopods are usually well developed (rarely obsolete), and the hand has a shape somewhat different from that of *forceps*. The fingers are very long, the moveable one, in large males, is two and one half to three times as long as the inner margin of the palm (in *forceps* about two and one-half times as long, or shorter); it is curved, with the outer margin more or less concave, and the fingers meet only near the tips, but generally for a somewhat greater distance than in *forceps*. The whole hand is comparatively longer, and less wide; it is about two and one-half to three times as long as broad. This means, that the palm is not as wide as in *forceps*, and, in consequence of this, the inner basal margin of the immoveable finger (anterior margin of palm) is not transverse, but rather oblique. In young males and females, the fingers are much less gaping, or not at all so, but always the greater length of hand and fingers, as compared with *forceps*, is evident.

For the rest, *placidus* has the general characters of the *rusticus*-group. It differs from typical *rusticus* in the hand, rostrum, and gonopods. The immoveable finger, in *placidus*, is very often bearded (as in *forceps*), chiefly in young specimens and females, but in males of the I form it is generally naked. In typical *rusticus* a beard may be present, but generally it is absent, or poorly developed.

Of the few specimens collected in the vicinity of Florence, Alabama,

the males decidedly possess the hand of *placidus*, although the characters are not strongly expressed. The male from Shoals Creek agrees with *placidus* in the areola also, but in the one from the Tennessee at Florence the areola is wider, yet not distinctly shorter (it is exactly one-third or 33 per cent of the carapace). In both of these the median spine on the lower anterior margin of the carpopodite of the chelipeds is missing, and thus there is here an inclination towards *forceps*. The female from Shoals Creek has this spine, the areola is also normal, and the hand has rather long fingers. As has been mentioned above, in this region (Mussel Shoals), both *forceps* and *placidus* are found, and, according to what has been said, they seem to intergrade here. Unfortunately, males of the I form are not at hand.

From Barren River in Kentucky, I have a very strange form belonging here, and represented only by a male of the II form, 44 mm., long. In rostrum and areola it is *rusticus*, but the rostrum has a trace of a median carina. The lateral spines of the carapace are *absent*, a character sometimes found in the true *rusticus*. The gonopods have the outer part somewhat curved (as in the Cumberland-Duck form of *rusticus*). As to the presence or absence of a shoulder, nothing can be said. The chelæ, however, are very unlike to those of typical *rusticus*, and resemble rather those of *placidus*. They are long (nearly three times as long as wide), with long fingers (two and one-half times as long as the inner margin of the palm), which are subcylindrical, and decidedly gaping from the base to the tip, the gap being wider than the width of the moveable finger at its base. The sculpture of the hand is weak, and there is no beard at the base of the immoveable finger. The spine in the middle of the lower anterior margin of the carpopodite of the chelipeds is absent. It is much to be regretted that only this specimen is at hand: it seems to be normal (not a freak), and I have placed it with *placidus*, but it may be, that it represents a peculiar phase of *rusticus* in the Green River drainage.

My largest male I (Lewisburg) has a length of 74 mm., but I have a male II (Wartrace) of 84 mm. The largest females (one each from Kingston Springs and Lewisburg) are 78 mm.

As the type-locality of *placidus* we should take the one first given by Hagen (Lebanon, Tennessee). Quincy, Illinois, also is given, and "Texas," but the latter specimens probably do not belong here (see below).

The original description is not quite satisfactory in every detail, for

the reason that this form was mainly described in terms of comparison with *virilis*. However, most of the essential characters have been mentioned, either directly or implicitly, and good figures of the gonopods have been furnished (Hagen, Pl. 1, figs. 76 and 79). The narrower and more deeply excavated rostrum has been pointed out, and also the elongated and gaping fingers. The original material of Hagen has been re-described by Faxon (as form of *rusticus*), and according to him the specimens from Lebanon and Quincy agree with the specimens collected by myself, some of them not far away from the type-locality. Hagen's Texas specimens do not belong here, since the gonopods have a shoulder. However, we do not need to worry about the latter, since the locality is very vague, and they thus have no value for zoögeographical studies.

Of the specimens reported by Faxon ('90) as *rusticus* from Meramec (not Meramee) River, Dent Co., Missouri, from Osage River (rather Marais des Cygnes), La Cygne, Linn Co., Kansas, and Harpeth River, Franklin, Williamson Co., Tennessee, he says himself, that they correspond to *placidus*. This undoubtedly is correct with regard to those from the last locality, since I found this form in Harpeth River. But about those from Missouri and Kansas there is a good deal of doubt. Steele ('02, p. 28) gives *rusticus* for Missouri, and unites with it *neglectus* Faxon, with the suggestion that *medius* Faxon may also be conspecific. According to Steele's account, there is no doubt that these forms are closely allied, and possibly pass into each other in Missouri. It is to be regretted, however, that they have been simply lumped together, and no attempt made to study their geographical relations. No form has been mentioned by Steele, which would correspond to *placidus*, and thus it remains doubtful, whether the true *placidus* is found in this region, notwithstanding Faxon's record.

It is impossible to decide, what the Wisconsin-*placidus* is, reported by Bundy ('82, p. 181). Graenicher ('13, p. 118) does not mention it, and was unable to confirm the older records (Bundy) for *rusticus* from Wisconsin.

Of other localities recorded by Faxon ('98) for *rusticus*, some at least, located in Kentucky and Missouri, might also belong to *placidus*, but this cannot be decided without examination of the specimens. Thus I have omitted them, but that some *placidus*-like forms are present in the Green River drainage is shown by my specimen from Bowling Green (see above). It is also impossible to say, whether *C.*

*rusticus placidus* reported by Osburn and Williamson ('98, p. 21) from Hellbranch Creek, Franklin Co., Ohio (to Big Darby Creek and Scioto River) is the real *placidus*. In western Ohio (incl. Franklin Co.) the true *rusticus* is generally found.

***Cambarus (Faxonius) rusticus mirus* var. nov.**

KNOWN LOCALITIES.

**Elk River drainage.**

*Type-locality:* Hurricane Creek, Cumberland Springs, Moore Co., Tennessee. (1 ♂ I, 3 ♂♂ II, 1 ♀, Aug. 20, '23).

Rock Creek, Tullahoma, Coffee Co., Tennessee. (2 ♂♂ II, Aug. 18, '23).

Taylor's Creek, Estill Springs, Franklin Co., Tennessee. (1 ♂ I, 1 ♂ II, 1 ♀, Aug. 19, '23) (below Estill Springs).

Spring Creek, Estill Springs, Franklin Co., Tennessee. (1 ♀, Aug. 19, '23) (above Estill Springs).

**Duck River drainage.**

Little Duck River, Manchester, Coffee Co., Tennessee. (1 ♀, Aug. 21, '23).

SUMMARY OF DISTRIBUTION.

All my specimens come from five localities, four of which belong to the same, rather limited, drainage system (headwaters of Elk River), while the fifth is in close proximity to these (headwaters of Duck River). All are in the region of the descent from the "Highland Rim" (Siliceous group of Lower Carboniferous, Tullahoma beds) to the Central Basin of Tennessee and its southern continuation (consisting largely of Ordovician rocks). I found this form in very small creeks, as usual under stones, etc. Males of the I form were found on Aug. 19 and 20.

DIFFERENTIAL CHARACTERS.

Rostrum moderately broad, moderately excavated, with a moderate acumen, and with or without a faint keel (standing in this respect between *forceps-placidus* on one hand, and typical *rusticus* on the other). Lateral spines of the carapace very small or absent. Areola rather wide and short, with five to seven rows of dots at the narrowest part, always shorter than one-third of the carapace (30-32 per cent of the length of the carapace). Chelæ comparatively broad and short, the whole hand two to two and one-half times as long as its greatest width. Fingers not gaping, or only slightly so in old males, the gap

never as wide as one of the compressed, tapering (not subcylindrical) fingers. Moveable finger from one and one-half to nearly two times as long as the inner margin of the palm (thus they appear here even shorter than in typical *rusticus*). Inner base of immoveable finger somewhat bearded, chiefly in the females and young. Tubercles of hand and fingers very weak, inner margin of palm and outer margin of moveable finger almost smooth, except for dots. Gonopods of the *rusticus*-type, with a distinct shoulder in the male of the I form; outer tip gently recurved at the end, longer than the inner.

Measurements (of type-set): ♂ I, about 48 mm.; largest ♀, 48 mm. I have a male I from Taylor's Creek of 55 mm., and a ♂ II from Rock Creek of 53 mm. Thus this seems to be a rather small form.

This is practically a *rusticus* with an unusually broad areola and comparatively smooth carapace and chelæ. In the development of the lateral spine it is variable. It is a local race of *rusticus*.

### **Cambarus (Faxonius) rusticus rusticus Girard (1852).**

The synonymy given for *rusticus* by Faxon ('85a, p. 108) should be corrected according to the views advanced here; that *placidus* is a variety of *rusticus*, and that *juvenilis* does not belong here, but should be brought together with *putnami* and *spinusus* (see below). Thus the references to either *placidus* or *juvenilis* should be cut out. I add here the following quotations of papers published after Faxon's revision, which undoubtedly apply to the genuine *rusticus*.

- C. rusticus* (*pro parte*) FAXON, '85b, p. 361;—UNDERWOOD, '86, p. 372;—FAXON, '98, p. 658;—HAY, '99, pp. 960, 962, 964;—STEELE, '02, p. 28, Pl. 6, figs. 1-13; HARRIS, '03, p. 121;—FAXON, '14, pp. 375, 418.  
*C. rusticus* FAXON in: KIRSCH, '95, p. 332;—HAY, '96, p. 503, fig. 14;—OSBURN and WILLIAMSON, '99, p. 48;—PEARSE, '10a, p. 74;—PEARSE, '10b, p. 17, Pl. 3.  
*C. (Faxonius) rusticus* (*pro parte*) ORTMANN, '05b, pp. 112, 133.  
*Faxonius rusticus* WILLIAMSON, '07, p. 753.

The following references should be left out as doubtful or positively not applying to the typical *rusticus*.

- C. rusticus* FAXON, '90, p. 632.—According to Faxon's own statement, these specimens belong to *placidus*. However, specimens from Missouri and Kansas are doubtful (see under *rusticus placidus*).  
*C. rusticus* HARRIS, '00, p. 271.—After Faxon, referring to the Kansas-form, which may or may not be the real *rusticus*.  
*C. rusticus* HAY, '02a, p. 235.—From Green River, Kentucky. Record founded only upon young specimens, not typical according to Hay's own statement. The identification cannot be accepted without further confirmation.

*Type-locality*: Ohio River, Cincinnati, Hamilton Co., Ohio (Girard).

## KNOWN LOCALITIES IN OUR REGION.

**Cumberland drainage.**

Harpeth River, Belleview, Davidson Co., Tennessee. (1 ♂ II, 1 ♀, Aug. 28, '21).

Harpeth River, Franklin, Williamson Co., Tennessee. (1 ♂ II, Aug. 27, '21).

**Duck drainage.**

Big Bigby Creek, Mount Pleasant, Maury Co., Tennessee. (2 ♀ ♀, Aug. 25, '21).

West Rock Creek, Lewisburg, Marshall Co., Tennessee. (1 ♂ I, 1 ♂ II, 2 ♀ ♀, Aug. 26, '23).

All of these specimens represent a peculiar phase of *rusticus*, not fully typical (see below). This form is restricted, thus far, to the region indicated by the above localities, *i. e.* to Cumberland and Duck drainages in the interior Basin of Tennessee.

DISTRIBUTION OF *C. RUSTICUS RUSTICUS*.

The real *rusticus* is positively known from the Ohio River northward, chiefly in the drainages of the Ohio from western Ohio down to the Wabash River. From the upper part of the Wabash drainage it has crossed over into the Great Lakes drainage (Maumee and western Lake Erie, in northern Indiana and northwestern Ohio). Beyond these states the distribution is somewhat uncertain. It has been reported as far west as Michigan, Wisconsin, Iowa, Missouri, and Kansas. Kentucky is also among the states where it is said to be found (Salt River drainage), but some of the records from Kentucky are to be positively referred to another species. The specimen from Barren River, mentioned above under *placidus*, possibly indicates the existence of a peculiar *rusticus*-form in this region which stands between *rusticus* and *placidus*. The older records of *rusticus* from Tennessee probably all belong to *placidus*. Yet I have found that there is, in the drainages of Cumberland and Duck Rivers, a form closely resembling typical *rusticus*, and different from *placidus* (with which it is found associated), which, to a degree, forms a connection between the two, but in a different way from that of the Barren River specimen.

CHARACTERS OF THE TYPICAL *RUSTICUS*.

(As found from the Ohio northward).

Rostrum wider, with shorter acumen, less concave above. Lateral spines of carapace present, but sometimes rudimentary. Areola

narrow and long, with two to four rows of dots in the narrowest part, and always distinctly longer than one-third of the whole carapace (34-37 per cent). Hand of chelæ comparatively short and wide, from two to two and one-half times as long as wide. Moveable finger somewhat shorter or longer than twice the length of the inner margin of the palm (on the average about twice as long). Immoveable finger generally naked at the inner base, rarely a little bearded. Inner margin of hand with a double row of tubercles, outer margin of moveable finger also with tubercles. Outer tip of gonopods straight, longer than the inner; shoulder well developed in the male of the I form.

#### CHARACTERS OF THE CUMBERLAND FORM.

This is closely allied to the typical phase, and agrees with it in the general shape of the rostrum, in areola, and hand, but differs in the occasional presence of a weak keel on the rostrum, and in the outer tip of the gonopods, which is always slightly recurved. It thus somewhat approaches the *placidus*-type, yet it is easily distinguished from the latter by rostrum and hand, and the presence of a shoulder on the gonopods. I do not think that this warrants the creation of a new variety, but it serves to demonstrate, that *placidus* should be regarded merely as a variety of *rusticus*.

#### **Cambarus (Faxonius) juvenilis** Hagen (1870).

- C. juvenilis* HAGEN, '70, p. 66, Pl. 1, figs. 29-33, Pl. 3, fig. 157;—SMITH, '74, p. 639.  
*C. putnami* FAXON, '84, p. 131;—FAXON, '85a, p. 118, Pl. 5, fig. 5, Pl. 9, fig. 6;—FAXON, '85b, p. 361;—UNDERWOOD, '86, p. 372;—HAY, '96, p. 504, fig. 15 (description of gonopods not quite correct: figure fair, but does not show shoulder);—HAY, '99, pp. 960, 964;—HAY, '02a, p. 236;—HARRIS, '03, p. 121;—ORTMANN in WILLIAMSON, '05, p. 311;—FAXON, '14, pp. 377, 419.  
*C. rusticus (pro parte)* FAXON, '85a, p. 112 (discussion of *juvenilis*);—FAXON, '85b, p. 361 (specimens from Little Hickman, Kentucky);—UNDERWOOD, '86, p. 372;—HARRIS, '03, p. 121.  
*C. spinosus (pro parte)* FAXON, '85a, p. 115, Pl. 9, fig. 7 (specimens from Cypress Creek, Alabama);—FAXON, '85b, p. 361;—UNDERWOOD, '86, p. 373;—HAY, '99, pp. 960, 964;—HARRIS, '03, p. 130.  
*C. spinosus* FAXON, '98, p. 658;—ORTMANN, '13, p. 334.  
*C. (Faxonius) putnami* ORTMANN, '05, pp. 112, 133.  
*C. rusticus* ORTMANN, '13, p. 334.

*Type-locality:* Kentucky River, Little Hickman, Jessamine Co. Kentucky. (Hagen).

## KNOWN LOCALITIES.

**North of Ohio River.**

Brookville, Franklin Co., Indiana. (Hay, *putnami*) (Whitewater drainage).

**Big Sandy drainage.**

Barrenshe Creek, Horsepen Creek, War Creek, Peeryville, McDowell Co., West Virginia. (Faxon, *putnami*).<sup>12</sup>

**Licking drainage.**

Licking River, Farmer, Rowan Co., Kentucky. (Ortmann, *rusticus*) (C. M. 5 ♂♂ I, 1 ♀, Sept. 27, and 28, '11).

Triplet Creek, Morehead, Rowan Co., Kentucky. (Ortmann, *rusticus*) (C. M. 1 ♂ I, 1 ♂ II, 1 ♀, Sept. 26, '11).

Fleming Creek, Pleasant Valley, Nicholas Co., Kentucky. (Ortmann, *rusticus*) (C. M. 1 ♂ II, Sept. 26, '10).

**Kentucky drainage.**

Kentucky River, Little Hickman, Jessamine Co., Kentucky. (Type-locality, Hagen, *juvenilis*).

Dix River, Hedgeville, Boyle Co., Kentucky. (3 ♂♂ I, Sept. 3, '24).

Fleming Fork Creek, Lytle, Lincoln Co., Kentucky. (1 ♂ II, 2 ♀♀, Sept. 2, '24) (to Dix River).

**Green drainage.**

Green River, Mammoth Cave, Edmonson Co., Kentucky. (Faxon, Hay, *putnami*) (C. M., 2 ♂♂ II, 1 ♀, Sept. 6, '21).

Barren River, Bowling Green, Warren Co., Kentucky. (1 ♂ II, 3 ♀♀, Aug. 11, '24).

Bear Creek, Grayson Springs, Grayson Co., Kentucky. (Faxon, type-locality of *putnami*).

Rocky Creek, Grayson Springs, Grayson Co., Kentucky. (Faxon, *putnami*).

**Cumberland drainage.**

Cumberland River, Orby, Bell Co., Kentucky. (1 ♂ I, 2 ♀♀, Sept. 10, '13) (near Cumberland Gap).

Pitman Creek, Burnside, Pulaski Co., Kentucky. (1 ♂ II, Sept. 1, '24) (to Cumberland River).

<sup>12</sup>Not "Perryville," as given. Barrenshe and War Creeks are about two miles above Yukon P. O.; Horsepen Creek is farther up, three miles south of Squirejim, forming the boundary toward Tazewell Co., Virginia. All these creeks go to Dry Fork and Tug Fork of Big Sandy River. Peeryville is about three to four miles farther down on the Dry Fork, and is now called English. See Topographic Atlas (Sheets: Tazewell, Welch, and Pounding Mill) West Virginia and Virginia.

Run tributary to South Fork Cumberland River, Burnside, Pulaski Co., Kentucky. (2 ♂♂ II, 1 ♀, Aug. 14, '23).

Rockcastle River, Livingston, Rockcastle Co., Kentucky. (Ortmann, in Williamson, *putnami*) (C. M., 2 ♂♂ II, 1 ♀, June 21, '04).

#### **Tennessee drainage below Walden Gorge.**

Cypress Creek, Lauderdale Co., Alabama. (Faxon, *spinosus*).

Cypress Creek, Florence, Lauderdale Co., Alabama. (1 ♂ I, 2 ♀♀, Aug. 24, '24).

Shoals Creek, Bailey Springs, Lauderdale Co., Alabama. (2 ♂♂ II, 1 ♀, Aug. 25, '24).

Shoals Creek, Lawrenceburg, Lawrence Co., Tennessee. (1 ♂ I, 1 ♀, Sept. 1, '23).

Courtland, Lawrence Co., Alabama. (Faxon, *spinosus*) (On Big Nance Creek, tributary to Tennessee River).

Run tributary to Richland Creek, Pulaski, Giles Co., Tennessee. (2 ♂♂ I, 2 ♂♂ II, 4 ♀♀, Aug. 29 and 30, '23) (to Elk River).

#### **Tennessee drainage above Walden Gorge.**

Clinch River, Walker's Ford, Claiborne Co., Tennessee. (Faxon, *spinosus*).

Clinch River, Fink, Russell Co., Virginia. (2 ♂♂ II, May 12, '13).

Clinch River, Raven, Tazewell Co., Virginia. (Ortmann, *spinosus*) (C. M., 2 ♂♂ I, 1 ♀, Sept. 21, '12).

Clinch River, Richland, Tazewell Co., Virginia. (Ortmann, *spinosus*) (C. M., 1 ♂ I, 2 ♀♀, Sept. 20, '12).

Clinch River, Cedar Bluff, Tazewell Co., Virginia. (1 ♀, with young, May 11, '13).

Indian Creek, six miles southeast of Cumberland Gap, Claiborne Co., Tennessee. (Faxon, *spinosus*) (to Powell River).

#### **Doubtful, spurious, or indefinite localities.**

A specimen from Osage River, Missouri, mentioned by Hagen (*juvenilis*), is not this, but stands closer to *rusticus* (See Faxon, '85a, p. 113). Compare also what has been said above about *rusticus* from Missouri.

Cumberland Gap Kentucky. (Faxon *putnami* and *rusticus*). Possibly in the Cumberland drainage. We may disregard this locality, since I am able to give a more exact place in this region (Orby). There is also a locality on the south side of Cumberland Gap, in the Powell drainage.

Knoxville, Tennessee and Bradford, Indiana, given by Faxon for *putnami*, and other localities in southern Indiana, given by Hay, are doubtful since the identification is not positive.

Specimens from Salt River, Kentucky, and from Perryville, Boyle Co., Kentucky. (Chaplin River drainage, to Salt River), mentioned by Faxon ('85a, p. 112) under *rusticus*, may belong here, but the remarks about them are too incomplete.

#### SUMMARY OF DISTRIBUTION.

The metropolis of this species is in the rivers of Kentucky, Licking, Kentucky, Green, and upper Cumberland. It is also found in the headwaters of Big Sandy, in West Virginia, and in Clinch River in Virginia and Tennessee. These localities are grouped around the highest parts of the Cumberland Mountains, and the adjoining portion of the Cumberland Plateau. The headwaters of these drainage systems closely interlock. This area is rather continuous, but belongs to different drainage systems.

This species also seems to be present north of the Ohio, in southern Indiana, and further, it is in the Tennessee drainage below Walden Gorge (Cypress, Shoals, Big Nance, and Richland Creeks). For the present, this latter area appears entirely disconnected from the range in the upper Tennessee (Clinch), unless a record, given by Faxon for "*spinosus*," belongs here, "Tennessee River, near borders of Georgia"; but this is entirely too indefinite. The record of *C. spinosus gulielmi* from Rossville, Georgia, does not refer to our species, but belongs to *erichsonianus* (see above).

*C. spinosus* Bundy (type-locality Rome, Floyd Co., Georgia, and also from Saluda River, South Carolina and Tar River, Rocky Mount, Edgecombe Co., North Carolina, according to Faxon) is still, as will be pointed out below, a doubtful form, and requires further study on the basis of better material. It may be different from *juvenilis*.

*C. juvenilis* is a river-form, living in larger and smaller streams, and sometimes in small runs (at Burnside, Kentucky). Males of the I form have been found at the end of August and in September; a female with young on May 11.

#### TAXONOMIC REMARKS.

The original description of *C. juvenilis*, given by Hagen, is sufficient to recognize this species, since the most important character, the long gonopods, has been mentioned and also correctly figured. Faxon has furnished further information, and he again emphasizes the difference of the gonopods from those of *rusticus*. Nevertheless he placed

*juvenilis* with *rusticus*, and described other material, with exactly the same gonopods, as a new species (*putnami*).<sup>13</sup> He also described and figured gonopods of specimens from Cypress Creek, in Alabama as *spinosus*, which are again identical. I possess topotypes of this "*spinosus*" from Cypress Creek. In all of these forms the other characters of rostrum, chelæ, areola, etc., are the same, subject only to very slight variations.

Whether the original *spinosus* of Bundy (from Georgia, North and South Carolina) belongs here, is doubtful. There are discrepancies in Bundy's and Faxon's descriptions, chiefly in the gonopods of those of the I form as described by Bundy which do not correspond to those of the II form (tips nearly equal in the I form, unequal in the II form), and do not correspond to Faxon's account of the Alabaman specimens. Thus the original *spinosus* remains doubtful, and more material from Georgia and the Carolinas should be investigated to settle this question. *C. spinosus* is said to have a shorter areola than *putnami*.

The rostrum of *juvenilis* is not of the *rusticus*-type, but rather of the *propinquus*-section including *erichsonianus*, with the margins parallel or slightly convergent anteriorly, and straight (not concave). The margins are elevated, but not distinctly thickened. Yet the condition of *rusticus* (slightly concave and thickened margins) may be seen occasionally in specimens from Kentucky (I have such from Licking River and upper Cumberland). The upper surface is more or less concave, and generally has no median keel. Yet Faxon ('14) mentions that a keel is present in specimens from upper Big Sandy, and I have found this keel, more or less distinctly, in many (but *not all*) specimens from the upper Clinch. Some specimens from Dix River, from Pulaski, and from Bailey Springs also have traces of this keel, while others have not.

The lateral spines of the carapace are present, larger or smaller. Branchiostegal spines small, tuberculiform, or missing. The external orbital angle is never spiniform, but consists of a blunt, inconspicuous projection, or may be nearly obliterated.

The areola is moderately narrow. In its narrowest part are three to four (rarely five) rows of dots. The length of the areola is about one-third of the length of the carapace, from 32 to 35 per cent of it, mostly 32 or 33 per cent, thus corresponding closely to the description given by

<sup>13</sup>The figures of the gonopods of *putnami* do not show the shoulder, although this is mentioned in the text.

Faxon for *putnami*. This also holds good for my specimens from Cypress Creek, Shoals Creek, and the Elk River drainage in southern Tennessee and Alabama. These specimens come from the same general region as Faxon's Alabaman specimens of "*spinosus*."<sup>14</sup>

The chelipeds and chelæ have no especially prominent characters. The hand is rather broad, the fingers are somewhat elongated. In large males they may be slightly gaping at the base, but in younger individuals, they are not gaping. The immoveable finger generally is bearded at the inner base, but this beard may be poorly developed or missing, chiefly in old males. The inner margin of the palm and the outer margin of the dactylopodite have the usual tubercles.

The carpopodite of the first peræopods has the three spines usually found, an interior one; another in the middle of the lower anterior margin; and an exterior one. Rarely there are accessory spines. The spines may be strong, sharp, or blunt, and the one at the lower anterior margin may be missing.<sup>15</sup> The two rows of spines on the lower side of the meropodite are, in most cases, indicated only by the presence of the anterior one of each row, but the inner row often shows small additional spines or serrations; rarely there are two to three spines in the outer row.

Gonopods long, slightly variable in length, but always reaching to the posterior end of the coxopodites of the first peræopods (barely reaching as far as that in specimens from the upper Clinch), and often a little farther (to the middle of the coxopodite). Tips long and slender, deeply split, the outer one, in the male of the I form, nearly straight, or very gently and uniformly curved all along its length, distinctly, often considerably, longer than the straight inner part. A distinct shoulder is present. In the male of the II form, the outer tip is nearly straight, but slightly recurved at the end, and it also is distinctly longer than the inner.

Annulus of the female strongly tuberculate, and in old females quite characteristic. The two tubercles of the anterior border are very well developed, and are separated by a deep and narrow cleft. They

<sup>14</sup>In the real *spinosus*, the areola is shorter, being only 29 per cent of the length of the carapace. Whether this is an important character, remains to be seen; but at any rate, specimens from the lower Tennessee are, in this respect, *putnami* (= *juvenilis*), and not *spinosus*. Faxon does not give exact measurements of areola and carapace of his specimens from Alabama.

<sup>15</sup>Absent in specimens from Pleasant Valley and from Burnside; in one from Dix River, and in three (out of four) from Bowling Green.

slightly incline backward, and overhang, in part, the narrow and deep transverse fossa. The posterior tubercle also is well developed. Of course in young females these features are not so strongly pronounced, but they generally serve to distinguish the female of *juvenilis* from the otherwise very similar female of *erichsonianus*; where the anterior tubercles of the annulus are less developed, are wider apart, and do not overhang the wider and shallower transverse fossa, where the posterior tubercle is about as high as, or even higher, than the anterior tubercles.

My largest male (I) (Florence) is 91 mm. long; another one (Orby) is 75 mm.; my largest female (Florence) is 87 mm.; another one (Pulaski) is 83 mm.

#### SECTION OF CAMBARUS VIRILIS.

Gonopods generally rather long (rarely somewhat shorter), reaching about to the second peræopods, deeply split, tips slender (rarely somewhat stout), and more or less gently *recurved*, both in the same direction. Always the third peræopods only with hooks in the male.

I have divided ('05, p. 110) this section into three groups according to the areola. The first group (*alabamensis*) contains two species (*alabamensis* and *compressus*), said to differ from the others by wide and short areola. I had then never seen any specimens belonging here, and the characters assigned to this group were taken from Faxon ('85a). I have now seen a specimen of *C. alabamensis*, and a close comparison of this with its original description and with that of *C. compressus* has convinced me that these two species are not so very closely allied. *C. compressus* possesses characters which are unique, and give it a rather isolated position, while *C. alabamensis* is more closely related to those species, which I have placed in the second group (*virilis*, see: '05, pp. 112, 113).

I now would arrange these groups as follows:

1. Group: (*virilis*).—Carapace not compressed; lateral spines present; rostrum mostly without keel; areola not obliterated (A number of species, some of them in our region, see below).
2. Group: (*palmeri*).—Carapace not compressed; lateral spines present; rostrum without keel; areola obliterated in the middle (Species: *palmeri*, *difficilis*, *mississippiensis*. Not represented in our region).
3. Group: (*compressus*).—Carapace compressed; lateral spines absent; rostrum with keel; areola not obliterated in the middle (Species: *compressus*).

I. GROUP OF *C. VIRILIS*.

This group contains the following species: *alabamensis*, *meeki*, *longidigitus*, *virilis*, *nais*, *pilosus*, *immunis*, *validus*; the first and the last being found in our region. Of these, the last two, *immunis* and *validus*, are distinguished from the rest by the peculiar conformation of the rostrum which has strongly convergent margins and a very short acumen with the marginal spines mostly absent. The fingers of the chelæ also have peculiar features. The areola is of moderate length, a little over one-third of the carapace.

The other species are all closely allied to each other, possess a rostrum of rather normal shape with the acumen somewhat longer, and with more or less distinct marginal spines. The chelæ also are of normal shape; at any rate, they do not show the peculiar characters seen in *immunis* and *validus*. Among these species, *alabamensis* is peculiar by its short areola (28-30 per cent), and differs from the others chiefly in this character.<sup>16</sup>

Thus we get the following key for the species of the *virilis*-group.

- a. Areola short (28-30 per cent of carapace) and comparatively wide.  
*C. alabamensis*.
- a'. Areola longer (at least 32 or 33 per cent of carapace) and narrower.
  - b. Rostrum with acumen rather normal, as long as, or longer than, the width of the rostrum at base; margins parallel, concave, or slightly convergent, with marginal spines (sometimes small). Fingers of chelæ not excavated or curved at base (Species: *meeki*, *longidigitus*, *virilis*, *nais*, *pilosus*. All extralimital).
  - b'. Rostrum with acumen considerably shorter than width of rostrum at base; margins distinctly convergent, without (rarely with small) marginal spines. Fingers of chelæ with peculiar features.
  - c. Moveable finger with a deep emargination at base of inner margin.  
Immoveable finger regularly curved . . . . . *C. immunis* (extralimital).
  - c'. Moveable finger without emargination. Immoveable finger curved strongly outward at base . . . . . *C. validus*.

***Cambarus (Faxonius) alabamensis* Faxon (1884).**

*C. alabamensis* FAXON, '84, p. 125;—FAXON, '85a, p. 104, Pl. 4, fig. 4, Pl. 10, fig. 3;—FAXON, '85b, p. 359;—UNDERWOOD, '86, p. 366;—HAY, '99, pp. 960, 962; HARRIS, '03, p. 70;—FAXON, '14, p. 420.  
*C. (Faxonius) alabamensis* ORTMANN, '05b, p. 112.

<sup>16</sup>Of the others, the areola is shortest in *longidigitus* (32 per cent), which, however, has a very narrow areola; then follow *nais* and *pilosus* with the areola respectively of 33 and 34 per cent; and *meeki* and *virilis* with the longest areola, (36 to 38 per cent).

*Type-locality:* Second Creek, Waterloo, Lauderdale Co., Alabama. (Faxon).

*Additional locality:* Tennessee River, Florence, Lauderdale Co., Alabama. (1 ♂ II, Aug. 26, '24).

The two localities are in the lower Tennessee drainage in the vicinity of the Mussel Shoals. It apparently is a river-form.

#### TAXONOMIC REMARKS.

This species was known hitherto only from Faxon's description and only from the type-locality. I have found an additional specimen not very far from the latter. There is no question but that it belongs here, for the main character, the short and comparatively broad areola, is distinctly seen, as is shown by the measurements. Length of body 52 mm; carapace 23 mm; areola 7 mm; width of areola 1 mm. Thus the areola is only 30 per cent of the carapace. This fairly well agrees with *alabamensis*, for which the measurements of two specimens published by Faxon, give even less (28 per cent of the carapace). The width of the areola does not fully agree with Faxon's types, for it is a good deal less. In the latter it is 36 and 43 per cent of the length of the areola, in my specimen only 25 per cent.<sup>17</sup>

My specimen corresponds well with Faxon's account. The rostrum is like that in the figure (Pl. 4, fig. 4), but it has no trace of the "broad, rounded, slightly elevated median carina near the tip," mentioned in the text (p. 104), but *not* indicated in the figure. The various spines of the carapace, which are small according to Faxon, are well developed in my specimen. The chelipeds agree with Faxon's account, but the hands are smaller. The immoveable finger is bearded at the inner base, as described.

The gonopods of my male (II) fully agree with the figures given by Faxon (Pl. 10, figs. 3a, 3a<sup>1</sup>); they reach to the middle of the coxopodites of the second peræopods.

<sup>17</sup>Yet it is considerably wider than in other species of the *virilis*-group, where the width of the areola (according to the few measurements published) is from 4 per cent of the length (*longidigitus*) to about 8 per cent (in *pilosus* and *virilis*). Concerning the differences of my measurements from those of Faxon, it should be kept in mind, that errors of a fraction of a millimeter easily are made, and would considerably alter the percentage. Faxon's *illustrations* often are not very reliable in this respect.

## AFFINITIES.

Aside from the areola, this species has no very prominent characters. It has the general "habitus" of *virilis*, but differs, among other minor items, in the shape of the gonopods, which are more strongly recurved. In this character *alabamensis* rather resembles *meeki*, *nais*, and *pilosus*. Possibly the bearded immoveable finger may be a peculiar character of this species, but we should not forget, that in other groups this is a rather variable feature.

According to the areola *alabamensis* appears as a primitive type of the *virilis*-group; and, if this is correct, its distribution is significant. It is found near the southwestern extremity of the Cumberland Plateau (Mussel-Shoals region of the Tennessee), and possibly indicates the original center of the *virilis*-group, which subsequently reached its greatest development and diversity in the Interior Basin. But this is only a theory, which should be confirmed by additional evidence, chiefly with regard to the limits of the present distribution of this species, which thus far is very unsatisfactorily known.

**Cambarus (Faxonius) virilis** Hagen (1870).

Faxon ('85a, p. 97) mentions this species from a pond at Bridgeport, Jackson Co., Alabama. The record is founded upon a *female* with mutilated rostrum, and Faxon himself admits, that his identification may be incorrect. *C. virilis* has not been found at any other place east of the Mississippi and south of the Ohio, the nearest place being in southern Illinois. I think this species should not be admitted to our list.

**Cambarus (Faxonius) immunis** Hagen (1870).

This species has been reported from our region, but the specimens taken for it are the next species, *validus* (which see).

But I wish to say a few words about this species since it is present immediately to the west of the Cumberland Plateau, in the region of the Mississippi Embayment in western Tennessee. Faxon gives it from Obion Co., Tennessee, and distinguishes this form as var. *spinirostris*. I have collected it (3 ♂♂ I, 4 ♂♂ II, 10 ♀♀) in a small run, tributary to Reelfoot Lake, at Spoutsprings, Obion Co., Tennessee, (Aug. 14, '24), and these specimens thus are *topotypes* of *spinirostris*. In most of them the marginal spines of the rostrum are present, although sometimes very small; yet in several, chiefly larger ones, they

are practically absent, the margin of the rostrum being simply angled at their place. Since the form with spines has also been found elsewhere, associated with normal *immunis*, and since chiefly younger specimens show these spines,<sup>18</sup> *spinirostris* should not be regarded as a variety, but merely as a variation of *immunis*, belonging largely to the juvenile stage.

On August 22, '24, I collected specimens (1 ♂ II, 6 ♀ ♀, all rather young) at another locality in this region, in a small stream tributary to Forked Deer River, Jackson, Madison Co., Tennessee. These all had marginal spines on the rostrum.

### ***Cambarus (Faxonius) validus* Faxon (1914).**

*C. immunis* (*pro parte*) HAGEN, '70, p. 71, Pl. 8, fig. b;—FAXON, '85a, p. 100.

*C. validus* FAXON, '14, pp. 382, 421, Pl. 7, figs. 3, 4, 8, Pl. 13, fig. 1.

#### **Known localities.**

Huntsville, Madison Co., Alabama. (Faxon, type-locality) (in drainage of Tennessee below the Gorge).

Nashville, Davidson Co., Tennessee. (Faxon) (in Cumberland drainage).

This species is known only from Faxon's account of it. The two localities, rather far apart, and in different drainage areas, do not give any information as to the character of its range.

### 3. GROUP OF *C. COMPRESSUS*.<sup>19</sup>

#### ***Cambarus (Faxonius) compressus* Faxon (1884).**

*C. compressus* FAXON, '84, p. 127;—FAXON, '85a, p. 105, Pl. 5, fig. 6, Pl. 10, fig. 2;—

FAXON, '85b, p. 359;—UNDERWOOD, '86, p. 368;—HAY, '99, pp. 960, 962;—

HARRIS, '03, p. 83;—FAXON, '14, p. 419.

*C. (Faxonius) compressus* ORTMANN, '05b, p. 112.

#### **Known localities.**

Second Creek, Waterloo, Lauderdale Co., Alabama. (Faxon, type-locality).

Cypress Creek, Lauderdale Co., Alabama. (Faxon).

This species is known only from two localities in close vicinity in the

<sup>18</sup>Faxon's specimens from Obion Co., Tennessee were all immature!

<sup>19</sup>The second group (of *C. palmeri*) is not represented in our region, but *C. palmeri* is found in the Mississippi Embayment in west Tennessee, and *C. mississippiensis* on the Coastal Plain in Mississippi. I have found *C. palmeri* in August '24 in North Fork of Obion River, Union City, Obion Co., Tennessee.

lower Tennessee drainage, and has never been found subsequently. Thus we must rely entirely upon Faxon's account of it. Its taxonomic and geographical relations are rather obscure, but it is a member of the *virilis*-group, which is chiefly distributed in the Interior Basin.

### Subgenus CAMBARUS Fowler (1912).

*Bartonius* (subgen.) ORTMANN, '05, pp. 97, 117 (Type: *Astacus bartoni* Fabricius).  
*Cambarus* (subgen.) FOWLER, '12, p. 341 (Type: *Astacus bartoni* Fabricius).

Gonopods distinctly separated at the tips, tips rather short, the outer, in the male I, entirely transformed into a horny spine. No accessory spines. Both tips sharply recurved, forming nearly right angles with the basal part. Male with hooks on third peræopods only.

I have ('05, pp. 118, 119) distinguished in this subgenus four sections, all of which are represented in our region. Their essential characters are set forth in the following key.

- a. Eyes rudimentary. Carapace subcylindrical. Chelæ long, subcylindrical (Cave forms).....Section of *C. hamulatus*.
- a'. Eyes present. Carapace depressed or compressed. Chelæ comparatively short and broad, depressed.
  - b. Rostrum with marginal spines. Areola generally comparatively wide, of medium length (but variable).....Section of *C. extraneus*.
  - b'. Rostrum without marginal spines. Areola wide or narrow, short or long.
    - c. Carapace depressed. Areola wide or narrow, but never linear (obliterated), shorter or longer.....Section of *C. bartoni*.
    - c'. Carapace compressed. Areola very narrow or obliterated in the middle, long.....Section of *C. diogenes*.

#### 1. SECTION OF *C. HAMULATUS*.

The chief character of this section is the rudimentary condition of the eyes. The three species belonging here are blind cave-forms. They differ from other sections also in the subcylindrical shape of the carapace, and the long, subcylindrical chelæ.

Only one species is found in our region (*hamulatus*), the other two (*setosus* Faxon ('89) and *ayersi* Steele ('02) ) exist in the Ozark-region of Missouri. *C. hamulatus* differs from *setosus* in the presence of marginal spines on the rostrum, and in the wide areola. *C. ayersi* has also marginal spines on the rostrum, but the areola is linear in the middle.

**Cambarus (Cambarus) hamulatus** (Cope and Packard) (1881).

*Orconectes hamulatus* COPE and PACKARD, '81, p. 881, Pl. 7, fig. 1.

*Cambarus hamulatus* FAXON, '84, p. 145;—FAXON, '85a, p. 81; Pl. 4, fig. 6; Pl. 9, fig. 1;—UNDERWOOD, '86, p. 369;—PACKARD, '88, p. 40, fig. 10;—HAY, '99, pp. 959, 966;—HAY, '02b, p. 435, fig. 8;—HARRIS, '03, p. 101;—FAXON, '14, p. 422. *C. (Bartoni) hamulatus* ORTMANN, '05b, p. 120.

**Known localities.**

Nickajack Cave, Shellmound, Marion Co., Tennessee. (Cope and Packard, type-locality) (Hay).

Wine House Cave, Shellmound, Marion Co., Tennessee. (Hay).

This species is well known by the descriptions furnished by Cope, Packard, and Hay.

**2. SECTION OF C. EXTRANEUS.**

Carapace more or less ovate, depressed, with or without lateral spines. Rostrum with marginal spines. Chelæ not very elongated, depressed, and rather broad, but a little more elongated than in the sections of *bartoni* and *diogenes*. Areola more or less wide, and of variable, moderate length. Eyes well developed.

The essential character is the *presence of marginal spines on the rostrum*. This is a primitive group, forming the transition to the section of *bartoni*.

Several species have been created, all belonging to our region, but I recognize only two of them, distinguished as follows:

- a. Antennæ with very long, compressed flagellum, ciliated, or bearded on inner side. Rostrum with strong marginal spines, concave margins, and long acumen. Lateral spine of carapace strong..... *C. cornutus*.
- a'. Antennæ with normal flagellum. Marginal spines of rostrum less strongly developed, margins not distinctly concave, acumen shorter. Lateral spine of carapace well developed, small, or absent..... *C. extraneus*.

**Cambarus (Cambarus) cornutus** Faxon (1884).

*C. cornutus* FAXON, '84, p. 120;—FAXON, '85a, p. 80, Pl. 5, fig. 1, Pl. 9, fig. 3;—UNDERWOOD, '86, p. 368;—HAY, '99, pp. 959, 962;—HARRIS, '03, p. 83;—FAXON, '14, p. 423.

*C. (Bartoni) cornutus* ORTMANN, '05b, p. 120.

*Type-locality*: Green River, Mammoth Cave, Edmonson Co., Kentucky. (Faxon).

This species thus belongs to the Cumberland Plateau, but up to the present time it is undoubtedly the rarest species of *Cambarus*, known only from the single individual (♂ I) described by Faxon. It is a

rather aberrant type on account of the peculiar conformation of the antennæ and the long areola, but in the characters of rostrum, etc., it appears as primitive. The finding of additional material of this species is highly desirable, and probably the ecological conditions, under which it lives, will be interesting.

### **Cambarus (Cambarus) extraneus** Hagen (1870).

- C. extraneus* HAGEN, '70, p. 73, Pl. 1, figs. 88, 89, Pl. 3, fig. 156;—FAXON, '85a, p. 84;—FAXON, '98, p. 650;—HAY, '99, p. 966;—ORTMANN, in WILLIAMSON, '05, p. 310;—FAXON, '14, p. 422.  
*C. (Bartonijs) extraneus* ORTMANN, '05b, pp. 120, 134.  
*C. girardianus* FAXON, '84, p. 117;—FAXON, '85a, p. 78, Pl. 4, fig. 1, Pl. 9, fig. 2;—HAY, '99, p. 966.  
*C. extraneus girardianus* FAXON, '98, p. 650;—FAXON, '14, p. 422.  
*C. (Bartonijs) girardianus* ORTMANN, '05b, p. 120.  
*C. jordani* FAXON, '84, p. 119;—FAXON, '85a, p. 83, Pl. 3, fig. 3;—HAY, '99, p. 963;—FAXON, '14, p. 423.  
*C. (Bartonijs) jordani* ORTMANN, '05b, p. 120.

*Type-locality*: "Tennessee River, Georgia." (Hagen). This record is erroneous, since the Tennessee River is not in Georgia. I think, it would be well to select as type-locality the next one given by Faxon ('85a, p. 84); Etowah River, Rome, Floyd Co., Georgia.

### KNOWN LOCALITIES OF *C. EXTRANEUS*.

#### **Cumberland drainage.**

- Cumberland River, Orby, Bell Co., Kentucky. (1 ♂ II, Sept. 10, '13).  
 Harpeth River, Kingston Springs, Cheatham Co., Tennessee. (1 ♀, Aug. 31, '21).  
 Town Creek, Sparta, White Co., Tennessee. (1 ♂ I, 5 ♂♂ II, 6 ♀♀, Aug. 27, '22) (to Calf-killer and Upper Caney Fork).  
 New River, New River, Scott Co., Tennessee. (2 ♂♂ II, 4 ♀♀, Aug. 30, '24) (headwaters of South Fork Cumberland).  
 Rockcastle River, Livingston, Rockcastle Co., Kentucky. (Ortmann in Williamson) (C. M., 2 ♂♂ II, 2 ♀♀, June 21, '04).

#### **Tennessee drainage.**

- Duck River, Shelbyville, Bedford Co., Tennessee. (1 ♀, Sept. 1, '22).  
 Cypress Creek, Lauderdale Co., Alabama. (Faxon, type-locality for *girardianus*).  
 Cypress Creek, Florence, Lauderdale Co., Alabama. (1 ♀, Aug. 24, '24) (topotype of *girardianus*).

- Shoals Creek, Bailey Springs, Lauderdale Co., Alabama. (1 ♂ II, Aug. 25, '24).
- Keithly Branch, Bailey Springs, Lauderdale Co., Alabama. (1 ♂ II, Aug. 25, '24) (to Shoals Creek).
- Spring Creek, above Estill Springs, Franklin Co., Tennessee. (1 ♀, Aug. 19, '23) (to Elk River).
- Eastanaula Creek, Athens, McMinn Co., Tennessee. (Faxon, *girardianus*) (to Hiawassee River).<sup>20</sup>
- Piney River, Spring City, Rhea Co., Tennessee. (5 ♂♂ II, 3 ♀♀, May 18, '15) (to Tennessee).

#### Alabama drainage (upper Coosa.)

- Etowah River, Rome, Floyd Co., Georgia. (Faxon, supplementary type-locality for *extraneus*, type-locality for *jordanii*).
- Cartecay River, East Ellijay, Gilmer Co., Georgia. (2 ♂♂ II, Aug. 23, '22).

#### SUMMARY OF DISTRIBUTION

The range of this species includes the Tennessee drainage in southeastern Tennessee (but not in the headwaters, north of the Knoxville region) and northern Alabama. It is also found in upper Duck River, and extends into the southern tributaries of the Cumberland (Harpeth and Caney Fork), the headwaters of the Cumberland, and southward into the headwaters of the Coosa in Georgia. Possibly it goes farther south, as is indicated by a locality given by Faxon; "Big Cahaba River, Alabama." But this is too indefinite to be of any use.

This species belongs typically to creeks of moderate size; and is generally not found in very small streams, but occasionally in small rivers (the upper Cumberland, New, and Duck Rivers are the largest in which I found it. The smallest stream is Keithly Branch of Shoals Creek). Thus it is more of a river-form than a small-creek-form, and should follow, in its distribution, the laws governing the river-species. It lives under stones and other objects in the usual way.

The male of the I form, hitherto unknown, was found by myself (at Sparta) on Aug. 27. The gonopods are of the type of the subgenus *Cambarus*, and do not offer any special features. Females with eggs were collected at Spring City on May 18: they indicate that spring is the spawning season, as usual in the case of river-forms.

<sup>20</sup>This creek is given on Topographic Atlas (Sheet Cleveland) as "Oostanaula," but Eastanaula is correct.

## TAXONOMIC REMARKS.

Since I unite, under *C. extraneus*, three previously accepted species, and since variations of this form undoubtedly are connected with its decidedly discontinuous range, and since the study of these seems to have an important bearing upon the development of the drainage features in our region, I have to go more than usual into a detailed discussion of this species, so that no doubt may remain as to the justification of my views.

When Faxon separated his species *girardianus* and *jordani* from *extraneus*, he had of the latter nine specimens at his disposal (probably including the five (not six) reported by Hagen). Of *girardianus* he had five, and of *jordani* a single specimen. To these he added subsequently five specimens of *extraneus*, and two of *girardianus*. With the four specimens mentioned by Ortmann (in Williamson, '05), twenty-six individuals belonging to this group were known. My present material includes the four specimens mentioned previously, and thirty-five additional specimens, collected by myself in northern Georgia, northern Alabama, central and eastern Tennessee, and southeastern Kentucky.

In 1884 and 1885, Faxon pointed out the distinguishing characters of the three "species," but already in 1898 he recognized that forms intermediate between *extraneus* and *girardianus* occur, and the same observation was made by Ortmann in 1905. According to the present material, *nearly all specimens are intermediate, i. e.* they show a mixture of characters which have been assigned to these "species," and this, of course, means, that the characters are individually variable, and are not of specific value. This holds good, in the first line, for *extraneus* and *girardianus*, for which Faxon gives the following differences ('85a, pp. 79 and 84).

1. Areola broader and shorter in *extraneus* (length not over 33 per cent of carapace); longer and narrower in *girardianus* (length 35.4 per cent).
2. Palm of hand longer, fingers shorter in *extraneus*; the opposite in *girardianus*.
3. Upper margin of meropodite of chelipeds with two spines near distal end in *extraneus*; with only one spine in *girardianus*.
4. Thoracic sterna setiferous in *extraneus*; naked in *girardianus*.
5. Body smoother, punctations of carapace finer in *girardianus* than in *extraneus*.
6. Orbital angle with a more prominent spine in *girardianus* than in *extraneus*.

7. Lateral spine of carapace prominent in *extraneus*; rudimentary in *girardianus*.

I have to make the following remarks as to these characters:

1. There are differences in the length of the areola, and in a number of cases, the areola is even considerably longer than indicated by Faxon for *girardianus* (35.4 per cent), going up to 40.9 per cent. The width of the areola is correlated in a general way to the length; *i. e.* a longer areola is proportionally narrower.

2. The proportion of the length of the palm and fingers (1 : 1.9), given for *girardianus* (with longer fingers), is often found, or figures close to this, going up to 1 : 2.1. In other cases, the fingers are much shorter (1 : 1.3, to 1 : 1.5); but intergrades are found.

3. The upper distal end of the meropodite of the chelipeds may have one or two, but rarely three spines.

4. The setæ of the thoracic sterna are entirely unimportant: their presence apparently depends upon the condition of the individual. They are also present more frequently in males. They may have been worn off, when absent.

5. The punctations of the carapace, and its granulations, are variable, the latter largely depending on the age of the individual (young ones are smoother). The punctations may be coarse and comparatively distant from each other, or more closely set, with finer dots, more or less distinct, between the larger ones: these conditions pass insensibly into each other. The number of dots across the narrowest part of the areola varies, accordingly, between four and ten rows.

6. There is great variation in the spine of the external orbital angle; very often there is none.

7. Furthermore the lateral spine of the carapace is variable, and it may be entirely absent.

There are other differences, which may be taken from the descriptions of the two forms, but which have not been emphasized by Faxon. I pass over slight differences in the armature of the carpopodite of the chelipeds and the lower margin of the meropodite, since these rather variable features could never be used as specific characters, but I mention the inner margin of the palm, which has a double row of tubercles in *extraneus*, and a single, indistinct row in *girardianus* ("slightly serrated"). Just this character is a little more important, for there are certain sets of specimens well characterized by it. But it cannot be used to distinguish two species, as will be shown below.

In studying my material, I have discovered a few other characters, which should be considered.

The rostrum has been described in both *extraneus* and *girardianus*

as broad and excavated, with subparallel or slightly convergent margins, which end in marginal spines. These spines vary somewhat; they may be strong and distinctly upturned, or they may be (as described in *girardianus*) small, almost rudimentary, resembling small horny tubercles. The convergence of the lateral margins and the excavation of the upper surface is also variable: generally, more strongly convergent margins are connected with more deeply excavated surfaces. There are, however, numerous transitions. Finally the acumen of the rostrum may vary in its proportional length.

In both "species," the outer finger has been described as bearded at the base; this is actually the case in certain lots, but in others the base of this finger cannot be called "bearded," although there may be some hairs.

It should further be added, that in large specimens, chiefly males, the fingers become somewhat gaping at the base.

Among my material, there hardly is a set, which can be assigned to either *extraneus* or *girardianus*, and, moreover, there are hardly single individuals, which distinctly and unqualifiedly are the one or the other with the exception of one specimen from Cypress Creek, and two specimens from Shoals Creek and Keithly Branch. These are *girardianus*, agreeing with it in the characters given above under 1 (areola 35 per cent), 2 (length of palm to fingers = 1 : 1.9), 3, 5, and 6. But even here are slight differences. The thoracic sterna (character 4) in the two males are hairy, and the lateral spines of the carapace (character 7) are well developed in all three of them. These specimens also agree with *girardianus* in the shape and armature of the rostrum (marginal spines small), and armature of the hand (one row of serrations on inner margin of palm), carpopodite and meropodite.

Among my other sets, we cannot recognize these two forms; yet there are some regionally circumscribed groups, which possess peculiar features, but these features are not those given as the supposed specific differences of *extraneus* and *girardianus*.

The *first group* contains specimens from the Alabama and upper Tennessee drainages in Georgia and east Tennessee (East Ellijay and Spring City). Specimens from this region have been called by Faxon *extraneus* (Georgia) and *girardianus* (Athens, Tennessee).

My specimens resemble *girardianus* in the moderately long areola, the moderately developed lateral spines of the carapace, in the rather long fingers of the hand, and the single spine of the upper margin of the

meropodite of the chelipeds. But in the external orbital angle they are rather like *extraneus*, having no spine on it, or only a small one. Single individuals may have a shorter areola, and in one case (Spring City), the length of the areola is of the *extraneus*-type (33 per cent). These specimens stand nearer to *girardianus* than any others, except those from near the type-locality of the latter.

The *second group* includes specimens from the northern extremity of the range, the upper Cumberland drainage (Livingston, Orby, and New Rivers). These are all remarkable for their *double* row of tubercles on the inner margin of the palm (*extraneus*), and also the areola is here not very long, approaching that of *extraneus* even more distinctly than in the first group (length 30.2 to 34.5 per cent). The well developed lateral spines also point to *extraneus*. Yet other characters are those of *girardianus*. For instance, the external orbital angle has a spine. With regard to the upper distal spine of the meropodite of the chelipeds, all specimens from Livingston and New River agree with *extraneus* (two or three spines), while the one from Orby has only one spine, like *girardianus*. In the length of the fingers, this is in part reversed; specimens from Livingston have the long fingers (1 : 1.8) of *girardianus*, that from Orby the short fingers (1 : 1.4) of *extraneus*. But those from New River are peculiar in having *very long* fingers (1 : 2.1), and differing from all others in this respect.

On the average, these specimens of the second group stand closest to *extraneus*, but possess certain *girardianus*-features.

A *third group* is from central Tennessee, and contains specimens from the Caney Fork and Harpeth River drainages (middle Cumberland system), and from Duck River. This western set is noted for the unusually long areola (36 to 40.9 per cent), which, at the same time, is correspondingly narrow. This form outdoes in this respect the typical *girardianus*. Also other characters are of the *girardianus*-type, chiefly the presence of only one spine on the upper margin of the meropodite, and the inner margin of the palm which is simply serrated. On the other hand, in the extraorbital angle (without spine), and in the short fingers (1 : 1.3 to 1 : 1.6), these specimens are distinctly *extraneus*. The lateral spine in specimens from the Cumberland drainage is generally well developed (*extraneus*), but in the only one from Duck River it is missing (*girardianus*).

These specimens stand about midway between the two forms, but

in one particular feature (length of areola), they even go beyond the established limits of *girardianus*.

A young specimen from Estill Springs approaches geographically the type-locality of *girardianus*, but it agrees in the areola rather with the group from central Tennessee. It has, however, a double row of weak tubercles on the inner margin of the palm, and well developed spines on the carapace (*extraneus*).

The *fourth and last group* is formed by specimens from the region of the type-locality in Alabama: these represent the typical *girardianus*, with certain deviations, as explained above.

As to the rostrum, I should add, that strongly convergent margins and deep excavation are found in specimens from Ellijay and in some from Sparta. In the latter set we have the greatest variety, for we have here specimens with moderately convergent margins and moderate concavity, and also some in which the margins are practically parallel, and the excavation very shallow. The specimens from Livingston and New River have only a gently excavated upper surface, and have a peculiarity of their own; a comparatively long acumen not found elsewhere (also not in the specimen from Orby).

A "bearded" outer finger of the chela is found in all specimens from Ellijay and Spring City. In all others this character is missing, except in the typical *girardianus* from Cypress Creek and Shoals Creek, but again the one from Keithly Branch does not have this finger bearded.

From the above account of my material, it is clear that the characters used for distinguishing *extraneus* and *girardianus* are not reliable. There are variations in the crawfishes belonging to this aggregation, and some of these seem to be regionally restricted. However, they are not sufficient even to distinguish varieties. The four types described above might easily be subdivided, and we would finally arrive at the preposterous result of distinguishing specimens from almost each locality as a geographical variety. The only way is to regard *girardianus* simply as a synonym of *extraneus*. *C. extraneus* is a very variable species, but this is not astonishing when we consider its peculiar range, which is rather discontinuous, covering several, more or less independent, drainage-systems.

In the foregoing, we have not paid any attention to *C. jordani* Faxon, founded upon a single individual (♂ II) from Etowah River, Rome, Georgia, (where *extraneus* is also found). This specimen is

still the only one known, and its distinguishing characters are said to be as follows:

1. Rostrum broad, subplane, with the margins nearly parallel, and with long acumen.

2. Areola narrow. According to Faxon's measurements, it is about as long as that of *girardianus* (34.8 per cent as against 35.4 per cent in *girardianus*), but it is distinctly narrower (16 per cent of its own length, as against 31.8 per cent in *girardianus*).

In other characters it agrees partly with *extraneus* (sharp lateral spine, prominent extraorbital angle, without spine, two upper distal spines on meropodite), partly with *girardianus* (long fingers, and simply serrated inner margin of palm).

We have seen that specimens with a rostrum, as described for *jordani*, are occasionally found with *extraneus* (nearly flat rostrum at Sparta, and long acumen at Livingston and New River), and it should be mentioned that the acumen of the rostrum of *jordani*, as figured by Faxon ('85a, Pl. 3, fig. 3), greatly resembles these latter specimens, and hardly differs from that of *girardianus* (*ibid.*, Pl. 4, fig. 1). Furthermore, we know that in central Tennessee *extraneus* possesses an unusually narrow, although longer, areola. My measurements of specimens from Sparta give the width of from 14.5 to 23.5 per cent of its length; from Kingston Springs 15 per cent; from Shelbyville 16 per cent; from Estill Springs 22 per cent. In specimens from East Tennessee and Kentucky, these measurements vary from 25 to 42 per cent.<sup>21</sup>

Thus specimens of *extraneus* with flat rostrum and narrow areola like *jordani* do exist, associated with unquestioned *extraneus*-forms, and, in fact, relying only upon these characters, some specimens from central Tennessee actually should be called *jordani*. This, of course, tends to show that the single known individual of *jordani* is nothing but one of the many individual phases of *extraneus*.

My largest ♂ I (Sparta) measures 51 mm., but I have a ♂ II (New River) 80 mm. long. My largest ♀ (Florence) is 76 mm.

#### COLOR

Specimens from Sparta (found associated in the same creek with *C. bartoni cavatus*) attracted my attention on account of their peculiar

<sup>21</sup>Faxon's figure of *jordani* is very inaccurate in this respect, and it should be pointed out, that the exact measurement of the width of the areola is rather difficult.

color in life. At other localities I did not notice this; except at New River where I found a similar coloration but not so strikingly developed.

Carapace and abdomen light brownish red, cervical groove, rostrum, posterior margin of carapace, dark greenish, also anterior and posterior margins of abdominal segments. Telson light green, as also are the second to fifth peræopods. Under side pale, except that of telson, which is also light green. Chelipeds light brown-red, greenish near the joints. Tubercles of palm, at base of dactylopodite, and at articulation with carpopodite, red-brown. Margin of rostrum red-brown.

All specimens of this locality had these colors, and the contrast between the brown-red and greenish tints was rather marked and attractive. The specimens of *C. bartoni cavatus* found at the same place were of a rather dull greenish-olive color.

### 3. SECTION OF *C. BARTONI*.

Carapace ovate, more or less depressed, with, or mostly without, lateral spines. Rostrum without marginal spines. Chelæ comparatively short and broad, ovate. Areola wide or narrow, but never linear (obliterated), generally distinctly longer than half of the anterior section of the carapace, rarely shorter. Eyes well developed.

The missing marginal spines of the rostrum distinguishes this section from the preceding (*extraneus*), and the ovate and depressed carapace distinguishes it from the next (*diogenes*). In the latter, the areola is always very narrow and often obliterated (*linear*) in the middle, but the areola of certain forms of the *bartoni*-section leads to this condition gradually. Yet, in the latter section, the areola never is linear.

This section contains a number of species with a great number of varieties which in part are regionally restricted, in part appear as mere variations. Their distinction often is very difficult, and the literature about them consequently is rather confused. Our region is apparently the center of origin of the section, and also contains at the present time the majority of the known forms. The following key may serve to distinguish them, and for the sake of completeness, I also include in it a few forms which do not strictly belong here geographically.

- a. Areola shorter or longer, rather wide, with numerous, rather crowded dots, generally five or more in its narrowest part. Rostrum rather long, tapering; gently, or hardly at all, contracted into a long acumen.

- b. Areola rather short and wide. Margins of rostrum not swollen. Chelæ somewhat rough by dots, tubercles, and longitudinal ridges on the subconical fingers. Fingers not gaping, or only slightly so. . . . . *C. montanus*.
- c. Lateral spines of carapace present.
  - d. Inner margin of palm with two rows of tubercles.
    - C. montanus acuminatus*.
    - d'. Inner margin of palm with one row of tubercles.
      - C. montanus veteranus*.
  - c'. Lateral spines of carapace absent. . . . . *C. montanus montanus*.
- b'. Areola somewhat longer, but also wide. Margins of rostrum swollen. Chelæ rather smooth, with few dots, without distinct granulations or tubercles, and without ridges on the subcylindrical fingers. Fingers (in old specimens) widely gaping. . . . . *C. longulus*.
- c. Extraorbital angle little prominent, mostly rounded.
  - C. longulus longulus*.
  - c'. Extraorbital angle prominent, mostly spiniform.
    - C. longulus longirostris*.
- a'. Areola generally long, rarely short, moderately wide or narrow, the dots irregular, and not much crowded, in its narrowest part generally not more than 5. (Rostrum longer or shorter).
- b. Areola rather short, but rather narrow, with only about three dots in its narrowest part. Lateral spines present, but small. Carapace rough, strongly granulated. Chelæ rough, with tubercles in several rows toward the inner margin of the palm. Rostrum short and broad, suddenly contracted into a short acumen. . . . . *C. latimanus*.
- b'. Areola somewhat longer, wider or narrower, with two to five dots in its narrowest part. Lateral spines present or absent. Carapace not rough, but often somewhat granulated on the sides. Chelæ not very rough, tubercles only on inner margin of palm in one or two rows. Rostrum longer or shorter. . . . . *C. bartoni*.
- c. Rostrum longer, tapering, gently contracted into the long acumen. Palm at base of outer finger (in large specimens) with a distinct depression above and below. . . . . *C. bartoni robustus* (extralimital).
- c'. Rostrum shorter, suddenly contracted into a short acumen (rarely somewhat longer). Palm at base of outer finger without distinct depressions.
- d. Eyes normal. Lateral spine of carapace rarely present. Areola more or less elongated.
  - e. Areola moderately long (34-38 per cent), with three to five rows of dots in its narrowest part. Rostrum broad and short, with short acumen.
  - f. Margins of rostrum nearly parallel, sharply elevated, their anterior ends sharply angular, sometimes subspiniform. Surface of rostrum excavated. Lateral spines of carapace present or absent. Inner margin of palm with one or two rows of tubercles. . . . . *C. bartoni cavatus*.

- f'. Margins of rostrum more or less convergent, not sharply elevated, angles at base of acumen rounded. Surface of rostrum rather flat. Lateral spines mostly absent. Inner margin of palm rarely with two rows of tubercles, mostly only with one, or simply serrated.
- g. Upper surface of rostrum without median keel.
  - h. Inner margin of hand serrated, or with one, rarely with two rows of small tubercles..... *C. bartoni bartoni*.
  - h'. Inner margin of hand with a cristiform row of large tubercles..... *C. bartoni asperimanus*.
  - g'. Upper surface of rostrum with a median keel.  
*C. bartoni carinirostris* (extralimital).
- e'. Areola longer (about 40 per cent or more) and narrower, with only one or two rows of dots.
  - f. Carapace granulated on the sides. Hand with sharp and distinct tubercles..... *C. bartoni striatus* (= *graysoni* ?).
  - f'. Carapace rather smooth, weakly granulated. Hand with less distinct tubercles..... *C. bartoni laevis*.
- d'. Eyes reduced, but not absent. Lateral spines of carapace present, small. Areola long..... *C. bartoni tenebrosus*.

**Cambarus (Cambarus) montanus** Girard (1852).

GENERAL REMARKS.

Faxon ('14) was the first to correctly recognize this species. The essential characters of *C. montanus* (in the wider sense) are found in the *areola*, in the shape of the *rostrum*, and in the shape and sculpture of the *hand*.

The *areola* is rather short, sometimes shorter than one-third of the total length of the carapace, rarely slightly longer. My measurements vary between 29.8 and 36.8 per cent, but an *areola* of over 33 per cent is very rare. It is always broad, and is covered by a number of dots, which are more or less closely set, and uniform. In the narrowest part stand six to eight dots, rarely less (five), sometimes more (up to ten). (In *C. longulus*, the number of dots is about the same, but the *areola* is longer; in *C. latimanus*, the *areola* is also short, but narrower, with about three dots; in *C. bartoni*, the *areola* is longer and narrower, with five dots or less).

The *rostrum* of *C. montanus* is rather elongated with the lateral margins convergent and gently contracted toward the tip, forming a rather long acumen. There is a good deal of variation, however, as sometimes the contraction is very indistinct hardly marking off the

acumen. The margins of the rostrum are somewhat elevated, but not swollen. A similar shape of the rostrum is found in *longulus*, and in certain forms of *bartoni*. But in most *bartoni*-forms, and in *latimanus*, the rostrum is distinctly shorter, and the margins are suddenly contracted to form a short acumen.

The chelæ of *montanus* are rather indifferent. They are long-ovate, not very broad, with the fingers rather long, generally not gaping (or only slightly so in old specimens). Their sculpture is well developed, with distinct tubercles near the inner margin of the palm and along the margin of the dactylopodite. The chelæ are covered all over with dots which fall, upon the fingers, into longitudinal lines, forming furrows, including ridges. (In *C. longulus*, the chelæ are much smoother, with widely gaping fingers; in *bartoni*, the sculpture is similar, but the chelæ are shorter and broader; and in *latimanus*, they are also shorter and broader, but the sculpture is more strongly developed).

*C. montanus*, in all these characters, is a rather primitive type of the *bartoni*-section, and it varies considerably in other characters. Some of the latter, such as the extraorbital angle, granulation of the carapace, and hairiness of fingers, are individually variable, so that they cannot be used for the distinction of varieties. I have found, however, that the presence or absence of lateral spines on the carapace, and the number of rows of tubercles on the inner margin of the palm, are a little more constant, so that, generally, specimens from one and the same locality are alike in these characters. Thus it has been possible to distinguish three races under *montanus* (see key). Yet these races are *not species*, for the characters merge into each other.

I have found no evidence that *montanus* passes into *longulus*, nor into *latimanus*, but there is some slight indication of its connection with *bartoni* in specimens of *C. montanus acuminatus* from the Piedmont Plateau (Raleigh, North Carolina, see below).

***Cambarus (Cambarus) montanus acuminatus* (Faxon) (1884).**

- C. acuminatus* FAXON, '84, p. 113;—FAXON, '85a, p. 67, Pl. 3, fig. 5, Pl. 8, fig. 6;  
—UNDERWOOD, '86, p. 365;—FAXON, '90, p. 624;—HAY, '99, pp. 959, 964;—  
HARRIS, '03, p. 68;—ORTMANN, '13, p. 336.  
*C. (Bartoni) acuminatus* ORTMANN, '05b, p. 120.  
*C. bartoni acuminatus* FAXON, '14, pp. 391, 424.

*Type-locality:* Saluda River, at Farr's Mills, west of Greenville, Greenville Co., South Carolina. (Faxon, '14, p. 424).

KNOWN LOCALITIES.

Atlantic drainage.

- Indian Creek, Beltsville, Prince George Co., Maryland. (Faxon)  
(most northern locality, in Potomac drainage).
- Northwest Branch, Hyattsville, Prince George Co., Maryland.  
(Faxon) (to Anacostia and Potomac Rivers, near Washington,  
D. C.).
- Fredericksburg, Spotsylvania Co., Virginia. (Faxon)<sup>22</sup> (Rappa-  
hannock drainage).
- Deep Run, Fredericksburg, Spotsylvania Co., Virginia. (4 ♂♂ II,  
1 ♀, Aug. 17, '25) (Rappahannock drainage).
- Mountain Run, Culpeper, Culpeper Co., Virginia. (Ortmann, '13)  
(C. M., 2 ♀♀, June 3, '12) (Rappahannock drainage).
- Mattaponi River, Woodford, Caroline Co., Virginia. (3 ♀♀, one with  
eggs, Aug. 17, '25) (York River drainage).
- James River, Six Mile Bridge, Campbell Co., Virginia. (1 ♀, Aug. 31,  
'25) (below Lynchburg, at mouth of Beaver Creek).
- Ivy Creek, Lynchburg, Campbell Co., Virginia. (1 ♂ I, 1 ♂ II, Aug.  
29, '25) (to James River).
- Tinker Creek, Roanoke, Roanoke Co., Virginia. (Ortmann, '13)  
(C. M., 2 ♂♂ II, 3 ♀♀, June 10, '12) (Roanoke drainage).
- Mason Creek, Salem, Roanoke Co., Virginia. (Ortmann, '13) (C. M.,  
1 ♂ II, Aug. 13, '11) (Roanoke drainage).
- Neuse River, Raleigh, Wake Co., North Carolina. (Faxon, as *ro-*  
*bustus*).
- Rocky Branch, Raleigh, Wake Co., North Carolina. (Brimley Bros.  
4 ♂♂ I, 3 ♂♂ II, 8 ♀♀, May 7, '07) (to Walnut Creek and Neuse).
- Reedy Fork Cape Fear River, Greensboro, Guilford Co., North  
Carolina. (Faxon).
- Jones River,<sup>23</sup> Morganton, Burke Co., North Carolina. (Faxon) (to  
Catawba River).
- Small Run tributary to Catawba River, Marion, McDowell Co.,  
North Carolina. (1 ♂ II, May 16, '14).
- Oldfort, McDowell Co., North Carolina. (Faxon) (Catawba drainage).
- Saluda River, Farr's Mills, west of Greenville, Greenville Co., South  
Carolina. (Faxon, type-locality).

<sup>22</sup>Specimens recorded by Faxon ('14, p. 388) under *robustus*, but with the ex-  
press statement that certain characters *differ* from *robustus*. They are just those  
which belong to *acuminatus*. That the latter actually is found in the Rappahannock  
drainage, is shown by the specimens collected by myself at Fredericksburg and  
Culpeper.

<sup>23</sup>Not "James River."

**Interior drainage.**

- Blowing Rock, Watauga Co., North Carolina. (J. P. Moore, 1 ♀, June '93) (headwaters of New River).  
Swananoa River, Ashville, Buncombe Co., North Carolina. (1 ♀, May 13, '14) (to French Broad and Tennessee).  
Swananoa River, Black Mountain, Buncombe Co., North Carolina. (Faxon).<sup>24</sup>  
Cove Creek, Caryville, Campbell Co., Tennessee. (2 ♂♂ II, 1 ♀, Sept. 12, '15) (to Clinch River and Tennessee).

**Gulf drainage.**

- Chattooga River, Trion, Chattooga Co., Georgia. (4 ♂♂ I, 2 ♂♂ II, 3 ♀♀, May 19, '15) (to Coosa and Alabama Rivers).

**SUMMARY OF DISTRIBUTION.**

Thus far, the main distribution of *C. montanus acuminatus* seems to be on the Piedmont Plateau of the Atlantic slope, from Maryland (close to Washington, D. C.) to South Carolina. The new locality in the upper Coosa drainage (Trion) is probably connected with this range around the southern margin of the Appalachian system. This form also ascends into the mountains in Roanoke River (west of Blue Ridge), and in the Catawba drainage it goes up close to the foot of the high Mountains in North Carolina. Here the range crosses over the divide, and extends into the headwaters of New River (Kanawha system) and French Broad (Tennessee system).

An isolated locality is in Cove Creek at Caryville. However, disregarding the somewhat longer areola of one of the males, these specimens are absolutely typical, and distinctly belong to this form. This locality is on the other (western) side of the Great Allegheny Valley, at the foot of the Cumberland Escarpment. As we shall see below, the var. *veteranus* and the typical *montanus* are found in the Great Valley and on its eastern side (near the High Mountains). It is not impossible that additional investigations will modify the present impression concerning the range of *acuminatus* in the Great Valley.

*Ecology.* According to my experience, *C. montanus acuminatus* lives in smaller or medium-sized streams. The smallest run in which I found it is at Marion, North Carolina. I found it only once in a large river, the James at Six Mile Bridge, but here it was at the mouth of a

<sup>24</sup>Faxon also gives, French Broad River, North Carolina. This is rather indefinite, and might very well be dismissed, since other more exact localities in this drainage are known.

creek (Beaver Creek). All of the places had rapidly flowing water, and the crawfishes live under stones in the usual way. The female with eggs, collected at Woodford, was dug out of a hole on the bank, close to running water. In Chattooga River, at Trion, possibly the largest body of water (except James River), this form was abundant under stones, and *chiefly* among water weeds, but again in lively flowing water. At the latter locality, I found males of the I form (May 19), and, associated with them, two females with eggs. Another male of the I form was found in Ivy Creek, Lynchburg (Aug. 29) and another female with eggs at Woodford (Aug. 17). These dates probably indicate, that there is no restricted breeding season.

#### TAXONOMIC REMARKS.

*C. montanus acuminatus* is distinguished from the other forms of *montanus* by the presence of lateral spines on the carapace (mostly well developed), and the double row of tubercles on the inner margin of the palm. In the sets enumerated above these characters are uniformly present, yet, in the original description of *acuminatus*, the double row of tubercles is not mentioned ("serrato-tuberculate on internal border"). The figure is not clear enough to make out this character. But since several of my sets showing this feature have been collected in close vicinity to localities given by Faxon, we must consider it as important. In very young individuals the tubercles are weak, but stand in two rows.

In the general shape of the chelæ, my specimens are also rather uniform. The outline is elongated, with rather long fingers, and the surface has the sculpture described for the species. The fingers are not gaping, and are somewhat hairy, but not bearded. Only in a large male I from Lynchburg, the fingers are slightly gaping.

The areola varies in length, from 29.8 to 33.8 per cent of the carapace, but in one male from Caryville it is 35.4 per cent (the other male and the female have 32.1 per cent). This, apparently, is an isolated, exceptional individual, in which possibly, hybridisation with some other form is suggested. Of the dots of the areola, six to nine stand in the narrowest part. Generally, they are not exceptionally crowded, yet they are more so than in the *bartoni*-forms.

The rostrum varies in the length of the acumen and in the distinctness of the latter, that is to say, in the constriction at its base. Faxon's figure gives the extreme case of elongation, but, there are

specimens in which the constriction and the acumen are more distinct, the latter being longer or shorter. Specimens from the same locality vary in this respect.

Faxon makes special mention of the extraorbital angle, which may or may not have a spine; in his type, this angle was rounded. But, according to my material, it is mostly spiniform; only in the specimen from Ashville, and that from Six Mile Bridge, is it absent. It is small in the specimen from Marion, and in the specimens from Lynchburg. In one specimen from Culpeper it is small on the right side, and absent on the left.

My set from Raleigh deserves special mention, and probably corresponds to specimens mentioned by Faxon, from Raleigh as *robustus*. These agree with *acuminatus* in the double row of tubercles on the palm, and in the shape of the rostrum. The fingers of the hand are also similar, yet somewhat shorter in the average. They do *not* possess a trace of the depressions on the hand, characteristic for *robustus*. But then again, the areola is somewhat longer (32.8 to 36.1 per cent), and the dots are a little more irregular, yet rather numerous (five to six rows). The lateral spine is variable here, rarely well developed, usually small or represented by a tubercle.

These specimens, of course, are not typical *acuminatus*, but transitional toward *bartoni*, inclining to the *robustus*-phase. They probably indicate how *robustus* and typical *bartoni* originated from the *montanus*-stock.

**Cambarus (Cambarus) montanus veteranus** (Faxon) (1914).

*C. bartoni veteranus* FAXON, '14, pp. 389, 424, Pl. 13, fig. 2.

*Type-locality*: Indian Creek, Baileysville, Wyoming Co., West Virginia. (Faxon) (headwaters of Guyandot River, to Ohio).

KNOWN LOCALITIES.

**Kanawha drainage.**

Elk River, Cogar, Webster Co., West Virginia. (Faxon).<sup>25</sup>  
West Fork Greenbrier River, Durbin, Pocahontas Co., West Virginia. (Faxon).<sup>26</sup>

<sup>25</sup>Given as: Elk River, Cogar's Mill, West Virginia. A place named Cogar is in Webster County.

<sup>26</sup>Reported as *robustus*, (*l. c.*, p. 388), but, according to remarks made by Faxon, apparently belonging here. The specimens differ from *robustus* by wide areola and less prominent depressions on hand.

Crane Creek, near Montcalm, Mercer Co., West Virginia. (Faxon).<sup>27</sup>  
(tributary to Bluestone River).

**Guyandot drainage.**

Indian Creek, Baileysville, Wyoming Co., West Virginia. (Faxon,  
type-locality).

**Tennessee drainage.**

Brush Fork, Marlow, Anderson Co., Tennessee. (2 ♂♂ II, Sept. 2,  
'14) (to Clinch River).

Pistol Creek, Rockford, Blount Co., Tennessee. (3 ♂♂ II, 1 ♀, Sept.  
4, '14) (to Little River).

Fourmile Creek, Vonore, Monroe Co., Tennessee. (2 ♂♂ II, 1 ♀,  
Aug. 29, '14) (to Tellico River, and Little Tennessee).

Hiawassee River, Austral, Polk Co., Tennessee. (1 ♂ I, 1 ♀, Sept.  
19, '15).

**DISTRIBUTION.**

At least in part, the distribution of this form seems to overlap with that of *acuminatus*, namely, in the Great Valley in east Tennessee. It does not extend into the High Mountains eastward, nor to the Piedmont Plateau, as *acuminatus* does. On the other hand, this form advances into West Virginia, westward of the Allegheny Mountains, into a region which belongs to the Allegheny-Cumberland Plateau, (here its type-locality is found). But altogether, our information as to the range of this form is rather meager.

Where I found it, it was in rather small creeks (also at Austral, in a small slough of the main river), as usual under stones in running water. A male of the I form was captured on September 19.

**TAXONOMIC REMARKS.**

Only eleven specimens, collected at four localities in the Great Valley, are at hand, one of them a male I. They agree very well with each other, and also with Faxon's description of *veteranus*. The essential characters are the same as in *acuminatus*, with the exception, that the inner margin of the palm has only *one* row of tubercles. In addition, all of my specimens have the outer finger of the chelæ bearded on the inner base, and in the larger and more fully developed specimens (from Austral), the fingers are distinctly gaping at the base.

The rostrum is always distinctly contracted, with a rather long

<sup>27</sup>Also given as *robustus*, but the same remark applies as in the case of Durbin.

acumen. The areola measures from 31.7 to 36.8 per cent of the length of the carapace, and the extraorbital angle has a small spine.

The original description of *veteranus* mentions most of these characters. The areola, according to the measurements given, would be 34.7 per cent, and has many dots. The rostrum is long; the lateral spines of the carapace are present. The fingers of the hand are gaping, and the general shape of the hand is about the same as in my specimens from Austral. There are, however, a few minor differences. The inner margin of the palm is said to have only one row of tubercles, but there is another one, "obsolescent," running alongside of it. There is no "beard" on the base of the outer finger, and the extraorbital angle is not distinctly angular. The type of *veteranus* is much larger (total length 93 mm., carapace 49 mm.) than any of my specimens (♂ I from Austral about 59 mm., carapace 30 mm. ♀ from Austral, carapace 33 mm., largest ♂ from Marlow, 75 mm., carapace 38 mm.). It is possible that the above differences may be due to age. This much is sure, our specimens stand *very close* to *veteranus*, and the latter is not a form of *bartoni*, but of *montanus*. It is not identical with *acuminatus*, and is not the same as typical *montanus*, but stands between these two to a certain degree. It is quite possible that the true *veteranus* and our specimens, coming from somewhat different regions, represent two geographical races, but, I do not consider it advisable to separate them before more material has been studied.

**Cambarus (Cambarus) montanus montanus** Girard (1852).

*C. montanus* GIRARD, '52, p. 88.

*C. bartoni montanus* FAXON, '14, pp. 386, 423.

*Type-locality*: Tributary of James River, Rockbridge Co., Virginia. (Girard).

KNOWN LOCALITIES.

**Potomac drainage.** (It is desirable to have these confirmed!)

Cumberland, Allegany Co., Maryland. (Girard).

Shenandoah River, Clarke Co., Virginia. (Girard).

**James drainage.**

Tributary of James River, Rockbridge Co., Virginia. (Girard, type-locality).

**Kanawha drainage.**

- Gauley River, Gauley Bridge, Fayette Co., West Virginia. (1 ♂ II, May 8, '13).  
 "Barger's Springs,"<sup>28</sup> on Greenbrier River, Summers Co., West Virginia. (Faxon).  
 Greenbrier River, White Sulphur Springs, Greenbrier Co., West Virginia. (Girard).  
 Greenbrier River, Ronceverte, Greenbrier Co., West Virginia. (1 ♂ I, Aug. 11, '11).  
 Madam Creek, Hinton, Summers Co., West Virginia. (Faxon) (to New River).  
 New River, Hinton, Summers Co., West Virginia. (1 ♀, Sept. 12, '12).  
 New River, Pearlsburg, Giles Co., Virginia. (2 ♂♂ II, 1 ♀, Sept. 14, '12).  
 Bluestone River, Abb's Valley, Mercer Co., West Virginia. (Faxon).  
 Rich Creek, Spanishburg, Mercer Co., West Virginia. (Faxon) (to Bluestone).  
 Delashmeet Creek, Kegley, Mercer Co., West Virginia. (Faxon) (to Bluestone).  
 East River, Mercer Co., West Virginia. (Faxon) (to New River).  
 Wolf Creek, Rocky Gap, Bland Co., Virginia. (Faxon) (to New River).  
 Reed Creek, Wytheville, Wythe Co., Virginia. (Faxon) (to New River).

**Guyandot drainage.**

- Guyandot River, Baileysville, Wyoming Co., West Virginia. (Faxon).

**Big Sandy drainage.**

- Barrenshe Creek and War Creek, Yukon, P. O. (Peerysville), McDowell Co., West Virginia. (Faxon).  
 Horsepen Creek, (Squirejim), McDowell Co., West Virginia. (Faxon).

**Tennessee drainage.**

- Middle Fork Holston River, Marion, Smyth Co., Virginia. (1 ♀, Sept. 16, '12).  
 Cane Creek, Offutt, Anderson Co., Tennessee. (9 ♂♂ II, 6 ♀♀, Sept. 1, '14) (to Clinch River).  
 Emory River, Harriman Junction, Roane Co., Tennessee. (2 ♀♀, May 15, '15) (to Clinch River).  
 Toccoa River, Blue Ridge, Fannin Co., Georgia. (1 ♂ II, 1 ♀, Aug. 21, '22) (Hiawassee system).

<sup>28</sup>Probably this is meant to be "Bergen Springs."

## SUMMARY OF DISTRIBUTION.

The metropolis of this form seems to be in the upper Kanawha (New River) drainage in West Virginia and Virginia. Thence it has extended northeastward, having been reported from the James drainage (type-locality), and even from the Potomac. In West Virginia it has reached the headwaters of the Guyandot and Big Sandy, and in southwestern Virginia, the headwaters of the upper Tennessee, passing into Tennessee and even to the Hiawassee drainage in northern Georgia. Thus it is found in the Allegheny Mountains and the Great Valley from Maryland to Tennessee. In the Hiawassee it has entered the High Mountains of northern Georgia, and in West Virginia, it occupies parts of the Allegheny-Cumberland Plateau to the west of the mountains.

*Ecology.* Wherever found by myself, this form was in streams of moderate to large size. Cane Creek (Offutt) is the smallest creek. Middle Fork Holston is rather small at Marion. Emory and Toccoa are larger, and New, Greenbrier and Gauley Rivers are of considerable size. In all cases it lived in the usual way, under stones, in rather strongly flowing water. A male of the I form was obtained on Aug. 11.

## TAXONOMIC REMARKS.

The typical *montanus* is distinguished from the other *montanus*-forms chiefly by the absence of lateral spines on the carapace. With regard to the tubercles on the inner margin of the palm it varies, having sometimes only one row, sometimes two, with the second row generally indistinct.

The rostrum is elongated, gently contracted at the base of the longer or shorter acumen. The acumen, generally, is shorter and more distinctly marked off than in the other forms. The areola is rather short, 31.3 to 34.8 per cent of the carapace, with many, usually much crowded, uniform dots, in five to ten rows at its narrowest part. Extraorbital angle mostly with a distinct spine, but sometimes this is small or even missing.

The hand is of the typical shape and sculpture, with the fingers somewhat elongated, but generally less so than in *acuminatus* and *veteranus*. The fingers are not gaping and not bearded, with the exception of the set from Offutt, where they are distinctly bearded in all

fifteen specimens. An indistinct second row of tubercles on the inner margin of the palm is found in all specimens from the New River drainage. In the (large) female from Marion, the second row is distinct and well developed. In all others from the Tennessee drainage, only one row is present. The two specimens from Toccoa River are remarkable for the long acumen of the rostrum, with only a very gentle contraction at the base, much resembling, in this respect, the rostrum of *acuminatus*.

#### SUMMARY OF THE DISTRIBUTION OF THE MONTANUS-FORMS.

The various forms of *C. montanus* are found in an area comprising the southern Allegheny Mountains from the Potomac River to northern Georgia (upper Coosa drainage). They extend into the Blue Ridge and its southern expansion, the High Mountains of North Carolina and northern Georgia, eastward to the Piedmont Plateau (from South Carolina to the vicinity of Washington, D. C.), and westward upon a section of the Allegheny-Cumberland Plateau in southern West Virginia.

In the upper Tennessee drainage all three forms are found, but attention should be called to the fact that at no locality were two of the forms found associated, although different forms often occur rather close to each other. In these parts there is no regional separation of them, and their variability seems to be greatest. They appear as if the characters distinguishing them have developed (or else been preserved) independently, and that here and there special features have been introduced. The distinction of three varieties in this region thus appears as artificial and arbitrary, and probably is so.

This becomes somewhat different, when we consider the further distribution of each form. The typical *montanus* extends, within the Alleghenies proper, as far north as the Potomac drainage. From the James River northward it is the only one present. This form also occurs on the Allegheny Plateau in West Virginia, apparently following the New River system, and crossing into the headwaters of the Guyandot and Big Sandy. It has, at no point, gone eastward beyond the Blue Ridge mountains.

The form *veteranus* is found in West Virginia in the same general region as typical *montanus* (Guyandot and Kanawha), but here again it should be remarked, that at no locality both have been found associated, thus similar conditions prevail as in the Tennessee drain-

age.<sup>29</sup> The form *veteranus*, however, has not extended its range northward, being absent within the mountains in the New River system and to the north of it. It also has no extension of its range to the east.

*C. montanus acuminatus* is, in its distribution, more eastern and northern, and seems to have its center in the High Mountains in North Carolina (Tennessee and New drainages). It extends along the Blue Ridges to the upper Roanoke, and on the Piedmont Plateau from South Carolina to the Potomac Valley in Maryland. In this latter region we again see that *acuminatus* is nowhere accompanied by any of the other forms.

*C. montanus acuminatus* has the best claim to be regarded as a good species. In the eastern and northern part of its range it is rather pure. *C. montanus montanus* and *C. montanus veteranus* stand closer together, are more variable, and their distribution is more confused. Local forms are found among them. This is most evident in a large series.

#### **Cambarus (Cambarus) longulus longulus** Girard (1852).

*C. longulus* GIRARD, '52, p. 90;—FAXON, '90, p. 623;—FAXON, '98, p. 650;—HAY, '99, pp. 959, 966;—HARRIS, '03, p. 107;—ORTMANN, '13, p. 335 (*pro parte*), p. 337.

*C. (Bartonius) longulus* ORTMANN, '05b, p. 120.

*C. bartoni longulus* FAXON, '14, pp. 389, 424.

*Type-locality*: "Middle States" (Girard). The first exact locality, which might be selected as a supplementary type-locality is: South River, Waynesboro, Augusta Co., Virginia. (Faxon) (to Shenandoah and Potomac).

#### KNOWN LOCALITIES.

##### **Potomac drainage.**

Waynesboro, Augusta Co., Virginia. (Faxon, supplementary type-locality).

##### **James drainage.**

"Bath Co., Virginia." (Faxon) (indefinite, but in the James drainage).

North River, Buena Vista, Rockbridge Co., Virginia. (5 ♂♂ II, 3 ♀♀, June 8, '12).

<sup>29</sup>At Baileysville, West Virginia, typical *montanus* is in Guyandot River, *veteranus* in Indian Creek.

North River, Lexington, Rockbridge Co., Virginia. (Faxon).  
 Jackson River,<sup>30</sup> Lick Run, Botetourt Co., Virginia. (Faxon).  
 Jackson River, Covington, Alleghany Co., Virginia. (1 ♂ II, Aug. 11, '11).

**Kanawha drainage.**

Greenbrier River, Ronceverte, Greenbrier Co., West Virginia. (1 ♀, Aug. 11, '11).  
 Greenbrier River, White Sulphur Springs, Greenbrier Co., West Virginia. (Faxon).  
 Greenbrier River, Durbin, Pocahontas Co., West Virginia. (4 ♂ ♂ II, 1 ♀, Aug. 10, '11).  
 West Fork Greenbrier River, Durbin, Pocahontas Co., West Virginia. (Faxon).  
 Bluestone River, Abb's Valley, Mercer Co., West Virginia. (Faxon).  
 Reed Creek, Wytheville, Wythe Co., Virginia. (Faxon) (C. M., 1 ♂ I, 2 ♂ ♂ II, 1 ♀, Sept. 16, '12).

SUMMARY OF DISTRIBUTION.

This species is known from the drainages of the upper Kanawha (New) River, from the upper James (west of the Blue Ridge) and from the headwaters of the Shenandoah (Potomac drainage). In all three systems it is found within the Allegheny Mountains, but in New River it descends westward to the Allegheny plateau, and seems to be abundant in Greenbrier River.<sup>31</sup>

*Ecology.* *C. longulus longulus*, in distinction to other forms belonging to the *bartoni*-section, seems to be more of a river-species. Greenbrier, Jackson, and North Rivers are of good size, and the species is found, not in isolated specimens, but abundantly, living in the usual way under stones in strongly flowing water. However, it also ascends into the headwaters, but has never been found in very small streams or springs. A male of the I form was collected on Sept. 16.

TAXONOMIC REMARKS.

*C. longulus* has in common with *C. montanus* the elongated, tapering, rostrum with gently constricted margins, forming a rather long acumen. Also the areola is similar in so far as it has rather crowded,

<sup>30</sup>Given as "James River," but this is Jackson River.

<sup>31</sup>This part of the Allegheny Plateau resembles very much the mountains in its physical characters, the rivers being deeply cut into the highlands, and being very rough.

numerous, dots standing in six to nine rows on the narrowest part. Thus the areola is rather wide, but, in distinction to *montanus*, it is somewhat longer, its length being from 34.1 to 38.5 per cent of the length of the carapace (specimens with less than 36 per cent are rare).

A character peculiar to *longulus* is found in the margins of the rostrum. They are somewhat swollen (more or less so) so that the upper surface appears more concave than in the *montanus*-forms. Further, the shape and sculpture of the chelæ are characteristic, but only larger individuals show these peculiarities distinctly, the younger ones have them only slightly indicated. The most prominent feature is found in the gaping fingers. These are widely separated at the bases (thus making the palm rather broad), and meet only near the tips. Very often this produces a blunt angle on the outer margin of the immoveable finger so that the outline of the whole hand is somewhat elongate-rhombic. The hand and fingers are very little sculptured. The usual dots are present, but distant, shallow, and poorly developed. On the fingers they stand in irregular and indistinct rows, and do not form longitudinal furrows and ridges. Therefore, the fingers, being very little thicker at the bases, appear subcylindrical. The tubercles are very poorly developed, and form, on the inner margin of the palm, an indistinct row of weak serrations. In addition, the immoveable finger is very often densely bearded at the base of its inner margin. This character, however, is variable (it may change with age).

A lateral spine on the carapace is missing. I have never seen it in typical *longulus*. The extraorbital angle is always poorly developed, rounded or blunt. This is the only character in which it differs from the var. *longirostris*. Although this might seem to be insignificant, it justifies the distinction of the two varieties since they are also geographically separate.<sup>32</sup>

The fingers of the chelæ are of very variable length. In my specimens from the James drainage (nine specimens), they are comparatively short, hardly longer than the palm, even in the old males. In specimens from the New River drainage they are somewhat longer, chiefly in large males where the moveable finger may be over twice as long as the inner margin of the palm.

*C. longulus* appears to be a rather good species. That is to say, it is not connected by intergrades with related forms. The peculiar

<sup>32</sup>But there is some sort of transition: a blunt, rectangular angle is found in some specimens of the var. *longirostris* from Clinch River; see below.

shape and smoothness of the chelæ, the elongated rostrum with swollen margins, and the long, but broad, areola, are quite constant. Young individuals are not always easily recognized on account of the indifferent shape of the hand. It is a general rule in this genus, however, that young specimens do not have the specific characters well developed.

**Cambarus (Cambarus) longulus longirostris** (Faxon) (1885).

*C. bartoni longirostris* FAXON, '85a, p. 64;—FAXON, '85b, p. 358;—FAXON, '90, p. 623;<sup>33</sup>—FAXON, '98, p. 649;—HARRIS, '03, p. 75;—ORTMANN, '05b, p. 135;—FAXON, '14, pp. 389, 424.

*C. longulus longirostris* HAY, '99, pp. 959, 966.

*Type-locality*: "Eastern Tennessee and West Virginia" (Faxon, '85a). "Near the boundary between North Carolina and eastern Tennessee" (Faxon, '14). The first *exact* locality given by Faxon ('85b) is: Doe River, Carter Co., Tennessee, and, less exact ('85a): Cumberland Gap, Claiborne Co., Tennessee. But the latter specimens are not normal (they possess a lateral spine). Since I found the typical *longirostris* in Doe River, Elizabethton, Carter Co., Tennessee, practically the same place as that given by Faxon ('85b) we are justified in considering this the type-locality.

KNOWN LOCALITIES.

**Powell drainage.**

Cumberland Gap, Claiborne Co., Tennessee. (Faxon) (probably in Indian Creek).

**Clinch drainage.**

"Clinch River, West Virginia." (Faxon, '98) (this is nonsense, for the Clinch is not in West Virginia).

Clinch River, Cedar Bluff, Tazewell Co., Virginia. (2 ♂♂ I, Sept. 20, '12 and May 11, '13).

Clinch River, Richland, Tazewell Co., Virginia. (2 ♂♂ I, 3 ♀♀, Sept. 20, '12).

Clinch River, Raven, Tazewell Co., Virginia. (1 ♂ I, Sept. 21, '12). Tazewell, Claiborne Co., Tennessee. (Faxon, '98).<sup>34</sup>

Williams Creek, Liberty Hill, Grainger Co., Tennessee. (1 ♂ I, 1 ♀, Sept. 15, '15).

Cove Creek, Caryville, Campbell Co., Tennessee. (1 ♂ II, Sept. 12, '15).

Clinch River, Solway, Knox Co., Tennessee. (1 ♀, Sept. 12, '14).

<sup>33</sup>Listed twice in this article by mistake, "spinirostris."

<sup>34</sup>Given as *longulus*, but surely belongs here. Probably from a tributary (Balls Creek ?) of the Clinch.

**Holston drainage.**

Little Mocassin Creek, Gate City, Scott Co., Virginia. (1 ♂ II, May 16, '13).

Big Mocassin Creek, Mocassin Gap, Scott Co., Virginia. (2 ♂♂ II, 1 ♀, Sept. 9, '15).

Middle Fork Holston River, Marion, Smyth Co., Virginia. (2 ♂♂ I, 2 ♂♂ II, 1 ♀, Sept. 16, '12).

South Fork Holston River, Marion, Smyth Co., Virginia. (Faxon, '90).<sup>35</sup>

Beaver Creek, Bristol, Washington Co., Virginia. (1 ♂ II, 1 ♀, July 6, '13).

Muddy Creek, Blountville, Sullivan Co., Tennessee. (Faxon, '98).

Watauga River, Watauga, Carter Co., Tennessee. (1 ♀, July 14, '13).

Watauga River, Elizabethton, Carter Co., Tennessee. (Faxon, '90)<sup>36</sup> (C. M., 1 ♀, July 11, '13).

Doe River, Elizabethton, Carter Co., Tennessee. (Faxon, '85b. Type-locality) (C. M., 1 ♂ II, July 11, '13. Topotype) (to Watauga River).

Holston River, Noeton, Grainger Co., Tennessee. (1 ♂ II, 1 ♀, May 22, '14).

Holston River, Hodges, Jefferson Co., Tennessee. (1 ♀, May 25, '14).

Holston River, Mascot, Knox Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 6, '13).

Holston River, McMillan, Knox Co., Tennessee. (1 ♂ II, Sept. 16, '14).

Big Flat Creek, Corryton, Knox Co., Tennessee. (2 ♂♂ II, May 12, '14).

Knoxville, Knox Co., Tennessee. (Faxon, '98).<sup>37</sup>

**French Broad drainage.**

Greeneville, Greene Co., Tennessee. (Faxon, '98).<sup>38</sup>

French Broad River, Bridgeport, Cocke Co., Tennessee. (1 ♂ II, Sept. 3, '14).

Spring Creek, Hot Springs, Madison Co., North Carolina. (Faxon, '90).<sup>39</sup>

<sup>35</sup>Originally given as *longulus*, but in '14 Faxon suggests that these specimens belong here.

<sup>36</sup>Originally given as *longulus*; but placed later by Faxon ('14) with *longirostris*.

<sup>37</sup>Given as *longulus*, but surely belonging here. Locality somewhat indefinite.

<sup>38</sup>This also given as *longulus*. Locality not very exact, but possibly from Roaring Fork, tributary to Lick Creek and Nolichucky River.

<sup>39</sup>Originally given as *longulus*, but placed later ('14) with *longirostris*.

**Most southern locality.**<sup>40</sup>

South Chickamauga Creek, Ringgold, Catoosa Co., Georgia. (1 ♂ I, 1 ♂ II, 1 ♀, May 20, '15) (to Tennessee River).

## SUMMARY OF DISTRIBUTION.

*C. longulus longirostris* represents the typical *longulus* in the upper Tennessee drainage of Virginia, eastern Tennessee, North Carolina and northern Georgia. Specimens from the upper Clinch approach more closely the real *longulus* than specimens from other parts of the range (see below). This, possibly, is significant. The typical *longulus* has been reported repeatedly from this region. In part of the instances these specimens actually belong to *longirostris*. In the remaining localities (Tazewell, Greeneville, Knoxville), this is very likely true also, since in the whole region I never found a true *longulus*, but always the form *longirostris*.

In the Clinch, Holston, and French Broad drainages, the three main tributaries of the Tennessee, and in many of their affluents, this form seems to be common. It has not been found in the Tennessee River below Knoxville and the mouth of the Clinch, nor in its eastern tributaries (Little River, Little Tennessee, and Hiawassee Rivers). It may have been overlooked here, for it occurs again in Georgia, in a tributary (S. Chickamauga), that falls into the Tennessee at Chattanooga. This is the most southern locality known, and the one that is farthest downstream in the Tennessee drainage. The locality in Escambia Co., southern Alabama, is in the Escambia River drainage, not far from the Gulf, and is so widely remote from the rest of the range, and in so different a physiographical region, that I emphatically doubt its correctness.

*Ecology.* This form of the upper Tennessee River also prefers somewhat larger rivers. Its distribution is quite characteristic for a true river-form, being restricted to *one* drainage system, which forms a unit at the present time. Yet *C. longulus longirostris* also ascends into smaller streams, but again, it never is a form of small runs or springs. It is found, as usual, under stones, in flowing water.

I frequently found males of the I form. The dates are: May 11, May 20, and Sept. 15, 16, 20, and 21. (See above lists).

<sup>40</sup>The locality, Wills Creek, Pollard, Escambia Co., Alabama (Faxon, '98), is extremely doubtful (see: Ortmann, '05b, p. 135).

## TAXONOMIC REMARKS.

The characters and affinities of this form hitherto have been rather obscure. Faxon has correctly recognized its relation to *longulus*. The close similarity to it, chiefly with regard to the chelæ, has not been properly brought out, since fully developed males had not been observed. According to my material, which contains nine males of the I form, *longirostris* is almost identical with *longulus*, with the exception, that the external orbital angle is more prominent, sharply angular, or even spiniform. Only in specimens from the uppermost Clinch (Cedar Bluff, Richland, Raven) this is not so evident. In the eight specimens, which I have from these parts, this angle is distinct, but not very sharp; it is rectangular or even blunt. Therefore, there is apparently some transition between *longulus* and *longirostris*, and for this reason the two should be regarded as varieties of the same species.

For the rest, little need to be said. The rostrum in both forms has the same shape, but as a rule, the margins are less swollen in *longirostris*. The hand has the same general shape, the fingers are gaping, and of moderate length. The base of the outer finger may be bearded in *longirostris*, or it may be naked. There is great variability in his character, and the absence of a beard may be due to abrasion of the hairs.

Faxon ('85a) mentions the presence of lateral spines on the carapace of three specimens from Cumberland Gap. I have a single large female from Hodges (Holston River), which has a small, sharp, lateral spine on each side. In all others, this spine is absent.

**Cambarus (Cambarus) latimanus** (LeConte) (1855).

*Astacus latimanus* LECONTE, '55, p. 402.

*Cambarus latimanus* HAGEN, '70, p. 83, Pl. 1, figs. 43-46, Pl. 3, fig. 162;—FAXON, '85a, p. 69, Pl. 2, fig. 3;—FAXON, '85b, p. 359;—UNDERWOOD, '86, p. 370; FAXON, '98, p. 650;—HAY, '00, pp. 959, 965;—HARRIS, '03, p. 106;—FAXON, '14, pp. 395, 425.

*C. (Bartolius) latimanus* ORTMANN, '05b, pp. 120, 135.

*Type-locality:* Athens, Clarke Co., Georgia. (see: Faxon, '14).

KNOWN LOCALITIES.<sup>41</sup>

"Brook with muddy bottom," Raleigh, Wake Co., North Carolina. (Brimley Brothers, 4♀♀, Nov. 13, '03).

<sup>41</sup>Ocean Springs, Jackson Co., Mississippi (Faxon) is doubtful, the identification being unreliable; moreover, the locality does not fit into the known range.

Columbia, Richland Co., South Carolina. (Faxon).  
 Greenville, Greenville Co., South Carolina. (Faxon).  
 Athens, Clarke Co., Georgia. (LeConte, Faxon, type-locality).  
 Milledgeville, Baldwin Co., Georgia. (Hagen).  
 Roswell, Cobb Co., Georgia. (Faxon).  
 Auburn, Lee Co., Alabama. (Faxon).  
 Attala, Etowah Co., Alabama. (Faxon).

#### SUMMARY OF DISTRIBUTION.

The main range of this species does not strictly belong to our region. It is on the Piedmont Plateau, east of the Allegheny Mountains, from North Carolina to Georgia and northeastern Alabama. In the latter state, only, does it approach and enter the southern extremity of the Appalachians. It has been introduced here for comparison with the form which has been called *C. latimanus striatus* Hay. This, however, actually belongs to *C. bartoni* (See below), and is found on the Cumberland Plateau.

#### TAXONOMIC REMARKS.

I possess only four females from the northernmost locality (North Carolina). These, however, are typical in every respect, and agree very well with the description of the species. The chief characters are: the short, but rather narrow, areola, with only two to three rows of dots; the presence of small lateral spines on the carapace; the rather rough carapace and chelæ. The carapace is covered everywhere, except in the middle of the upper side, with numerous sharp granules. The chelæ have several rows of tubercles on and near the inner margin of the palm. The margin of the dactylopodite is also strongly tuberculated, and the hand and both fingers are strongly pitted. The pits (or dots) on the fingers forming deep, longitudinal furrows, with sharp ridges between them.

In my largest specimen (60 mm.), the length of the areola is 32 per cent of the length of the carapace, *i. e.*, shorter than in *bartoni*. The width, however, is about the same, with not more than three dots in the narrowest part. The rostrum is of the *bartoni*-type, rather broad and short, with short acumen. The roughness of the carapace and chelæ is remarkable, even in my specimens, which are females. This character will probably be still more pronounced in old males. It is, aside from the areola, the chief distinguishing character from *bartoni* and its subspecies and forms. In the geographical distribution also, *latimanus* is distinct from the *bartoni*-forms.

**Cambarus (Cambarus) bartoni** (Fabricius) (1798).

## GENERAL REMARKS.

This species is widely distributed over the Appalachian region, the Piedmont Plateau, the Allegheny-Cumberland Plateau, and extends its range far northward and northeastward. It is extremely variable, individually and regionally, and a number of varieties have been distinguished. These are preëminently found in the southern portion of its range. We are to regard the one found in eastern Pennsylvania as the typical form, however, this also has a range nearly co-extensive with that of the species in the wider sense.

The latter is characterized by a moderately long and moderately narrow areola, with irregular, not crowded, dots, standing in about three to five rows in its narrowest part; yet there are varieties with a somewhat narrower areola and with a smaller number of dots. The rostrum may be (in var. *robustus*) rather long and gently contracted into a rather long acumen, but in most cases it is short and broad, suddenly contracted, with short acumen. The chelæ are not very rough, and have tubercles only on the inner margin of the palm, rarely in two rows, mostly only in one. Often these tubercles are represented by a row of mere serrations. The carapace is rather smooth, but often somewhat granulated on the sides. The lateral spines are mostly absent, although they may be present in some cases.

All forms of *C. bartoni* prefer small creeks and runs, and they are often found in cool springs, burrowing under stones, or making holes very much like those made by the species of the *diogenes*-section. This holds good chiefly for the typical form, which is distinctly a spring-form, or a form of very small, often intermittent, runs. Other forms are in streams of somewhat larger size, but they all avoid rivers of a larger size.

**Cambarus (Cambarus) bartoni robustus** (Girard) (1852).

## (Partial bibliography).

*C. robustus* GIRARD, '52, p. 90;—HAGEN, '70, p. 80, Pl. 3, fig. 167.

*C. bartoni robustus* FAXON, '85a, p. 61;—FAXON, '14, pp. 387, 423, Pl. 3.

*C. (Bartoni) bartoni robustus* ORTMANN, '06, p. 388, Pl. B, fig. 2, Pl. 39, fig. 2, Pl. 40, fig. 3.

*Type-locality:* Humbler River, Toronto, Canada (Girard).

An *extralimital* form, introduced here only for comparison with the others, and because it has been erroneously reported from our region.

It is distinguished from all other *bartoni*-forms by the more elongated rostrum, with longer acumen; by the two rows of tubercles on the inner margin of the palm; the distinct depressions of the upper and lower side of the hand at the base of the immoveable finger; and the frequent presence of lateral spines on the carapace. The areola is of the *bartoni*-type, moderately long, with remote dots, numbering four to six in its narrowest part.

This is distinctly a *northern* form, being most abundant in the basin of the Great Lakes. It has been repeatedly reported from the middle, and even the southern Appalachian region. It is now evident, however, that it is not the true *robustus* that is found here, but forms belonging to the *montanus*-group. Faxon ('14) gives the following localities: West Fork Greenbrier River, Durbin, Pocahontas Co., West Virginia; Crane Creek, Mercer Co., West Virginia; Fredericksburg, Spotsylvania Co., Virginia; and Raleigh, Wake Co., North Carolina.

As has been shown above, the latter two localities should be referred to *C. montanus acuminatus*, and the two former to *C. montanus veteranus*, hence no positive records for *robustus* are left from our area.

### **Cambarus (Cambarus) bartoni cavatus Hay (1902).**

*C. bartoni cavatus* HAY, '02b, p. 435;—FAXON, '14, p. 425.

*Type-locality:* Powell River, Tazewell, Claiborne Co., Tennessee. (Hay).<sup>42</sup>

#### **Other known localities in the Tennessee drainage.**

Indian Creek, Cumberland Gap, Claiborne Co., Tennessee. (Hay) (to Powell River).

Ball Creek, Tazewell, Claiborne Co., Tennessee. (Hay) (to Clinch River).

Tennessee River, Knoxville, Knox Co., Tennessee. (Hay).

Tennessee River, Chattanooga, Hamilton Co., Tennessee. (Hay).

John Ross Spring, Rossville, Walker Co., Georgia. (Hay) (to Chattanooga Creek and Tennessee).

#### **Upper Caney Fork drainage (Cumberland System).**

Calfkiller River, Amanda, White Co., Tennessee. (2 ♂♂ II, 1 ♀, Aug. 29, '22).

<sup>42</sup>Tazewell is some distance from Powell River, the locality very likely is in the vicinity of Combs.

Town Creek, Sparta, White Co., Tennessee. (8 ♂♂ II, 4♀♀, Aug. 27, '22) (to Calfkiller).

Barren Fork, McMinnville, Warren Co., Tennessee. (3 ♂♂ II, 4♀♀, Aug. 31, '22).

### Duck drainage.

Little Duck River, Manchester, Coffee Co., Tennessee. (1 ♂ II, 2♀♀, Aug. 21, '23).

Thompson Creek, Raus, Bedford Co., Tennessee. (1 ♂ II, Aug. 20, '23).

### SUMMARY OF DISTRIBUTION.

Hay described this form from localities all situated in the upper Tennessee drainage; in the Tennessee River proper, small tributaries of it near Chattanooga, and from the Clinch and Powell drainages in the vicinity of Cumberland Gap. That is to say, this form is found on the eastern side of Cumberland Mountain and Walden Ridge. I did not find it in this region, although I collected typical *bartoni* here (in peculiar forms), and members of the *montanus*- and *longulus*-association. But then I found *cavatus*, or a form standing very close to it, on the west side of Walden Ridge, in the drainage of upper Caney Fork (above the falls), and in close vicinity, in the headwaters of Duck River. These latter localities all belong to the "Highland Rim," surrounding the Central Basin of Tennessee.

*Ecology.* In distinction from typical *bartoni* and other forms belonging here, *C. bartoni cavatus* is not a form of springs and very small runs, but belongs to creeks of a fair size, or small rivers: it even has been reported from the Tennessee River proper at Knoxville and Chattanooga. This ecological preference was most evident at Sparta and Amanda, where it exists in Town Creek and Calfkiller River. In springs coming out near the banks of the Calfkiller River, there was another form, which, although showing certain peculiarities, should be united with *C. bartoni bartoni*. *C. bartoni cavatus* lives under stones, as usual, and sometimes it constructs burrows of small dimensions on the banks.

### TAXONOMIC REMARKS.

This form has not been described in detail: Hay only gives the characters by which he believed it to be distinguished from the normal *bartoni*, namely, the "broad, parallel sided, deeply excavated rostrum," "the appearance of the deep excavation being partially given by the unusually high elevation of the margins of the rostrum."

In addition, it is said that the areola is narrower and more thickly punctate than in *C. bartoni bartoni*; that the epistoma is "triangular"; that the antennæ extend almost to the end of the abdomen; and that the carapace is more nearly cylindrical.

We cannot rely much on the latter characters. In my specimens, the areola, indeed, is rather narrow, but the dots are not more crowded. The rostrum is peculiar, and agrees quite well with the description given by Hay. Yet there is some variation in the margins as regards their convergence; they may be nearly parallel, or they may converge more or less. The excavation of the upper surface, produced by the elevation of the margins, is quite striking, and I notice in my specimens from the Caney Fork drainage, that the strong development of the margins generally causes, at the anterior end of them (base of acumen), a sharp angle (in typical *bartoni*, this angle is rounded), which may even appear as a small spine. It is never provided, however, with a horny tip, and is never upturned (as it is, more or less, in *C. extraneus*). This latter feature of the margins is not so evident in specimens from the Duck River drainage.

This peculiarity of the rostrum induces me to place my specimens with the var. *cavatus* of Hay, although I am not fully convinced that they actually are the identical form, having been found in another, yet not very distant, region. That my specimens are not absolutely the same form as *cavatus*, is further indicated by certain characters not especially mentioned by Hay.

As has been said, the areola is somewhat elongated (34–37.7 per cent of the carapace), and comparatively narrow (with two to four dots, rarely with five). The lateral spines of the carapace may be absent or present, small, or well developed. The chelæ have on the inner margin of the palm, very generally, a more or less distinct second row of tubercles, visible chiefly in large specimens, but obscure in younger ones. The fingers of the chelæ are not gaping, and are usually somewhat bearded on the base of the outer finger; yet the beard may be absent (so in my largest female from Sparta). The extraorbital angle may be simply angular, but in the most cases it has a small and sharp spine.

All of these characters constitute minor deviations from the typical conditions seen in *C. bartoni bartoni*, and are variable.

My largest male (II) (Manchester) measures: 69 mm., my largest female (Sparta) 97 mm.

**Cambarus (Cambarus) bartoni bartoni** (Fabricius) (1798).  
(Partial Bibliography).

*Astacus bartoni* FABRICIUS, 1798, p. 407.

*Cambarus bartoni* GIRARD, '52, p. 88;—HAGEN, '70, p. 75, Pl. 1, figs. 47-50, Pl. 2, figs. 135-139, Pl. 3, fig. 166;—FAXON, '85a, p. 59;—HARRIS, '03, p. 72;—ORTMANN, '13, pp. 335, 337 (*pro parte*);—FAXON, '14, pp. 383, 423.

C. (*Bartoni*) *bartoni* ORTMANN, '05b, pp. 120, 134;—ORTMANN, '06, p. 377, Pl. B, fig. 1, Pl. 39, figs. 1a-1f, fig. 8, Pl. 40, fig. 2.

*Type-locality*: North America (Fabricius). *First exact locality*: Philadelphia, Pennsylvania. (Harlan, '30).

LOCALITIES IN THE APPALACHIANS AND VICINITY, SOUTH OF THE  
POTOMAC, CHEAT, AND LITTLE KANAWHA RIVERS.  
EASTERN WATERSHED.

**Potomac drainage.**

Broad Run, Fauquier Co., Virginia. (Faxon) (to Occoquam and Potomac Rivers).

Alexandria Co., Virginia. (Faxon).

Gap Run (near Rectortown), Fauquier Co., Virginia. (Faxon) (to Goose Creek and Potomac River).

Clarke Co., Virginia. (Faxon) (lower Shenandoah River).

Waynesboro, Augusta Co., Virginia. (Faxon) (upper Shenandoah).

Orkney Springs, Shenandoah Co., Virginia. (Faxon) (upper Shenandoah).

Small run, Cherry Run, Morgan Co., West Virginia. (1 ♂ I, 3 ♀ ♀, Sept. 23, '04) (to Potomac).

West Branch Potomac River, Circleville, Pendleton Co., West Virginia. (Faxon).

Patterson Creek, Mineral Co., West Virginia. (Faxon) (to North Branch Potomac).

Patterson Creek, Williamsport, Grant Co., West Virginia. (Faxon).  
North Branch Potomac River, South Cumberland, Allegany Co., Maryland. (2 ♂♂ II, 1 ♀, May 9, '05).

Small Run, Rawlings, Allegany Co., Maryland. (3 ♂♂ I, 3 ♂♂ II, 4 ♀ ♀, May 9, '05) (to North Branch Potomac).

Small run and springs, Stoyer, Garrett Co., Maryland. (1 ♂ I, 2 ♂♂ II, Aug. 1, '05) (to North Branch Potomac).

**Rappahannock drainage.**

Stafford Co., Virginia. (Faxon) (Rappahannock or Potomac drainage?).

Stony Man Mountain, Madison Co., Virginia. (Faxon) (drainage of Hazel River, to Rappahannock).

**James drainage.**

Small run, Charlottesville, Albemarle Co., Virginia. (1 ♂ I, 1 ♂ II, 2 ♀ ♀, June 6, '12) (to Rivanna and James Rivers).  
Spring, Lynchburg, Campbell Co., Virginia. (4 ♀ ♀, Sept. 1, '25) (to Fishing Creek and James River).  
Bath Co., Virginia. (Faxon) (headwaters of Jackson River).

**Chowan drainage.**

Franklin, Southampton Co., Virginia. (Faxon).  
Lunenburg, Lunenburg Co., Virginia. (Faxon).

**Roanoke drainage.**

Peaks of Otter, Bedford Co., Virginia. (Faxon) (Otter River).

**Neuse drainage.**

Kinston, Lenoir Co., North Carolina. (Faxon).

**Catawba drainage.**

Newman's Fork, Blue Ridge, McDowell Co., North Carolina. (Faxon).

INTERIOR WATERSHED.

**Headwaters of Monongahela.**

Blackwater River, Davis, Tucker Co., West Virginia. (3050' elevation) (6 ♂ ♂ II, 6 ♀ ♀, Aug. 2, '05) (Cheat drainage).  
Small run, Hampton, Upshur Co., West Virginia. (1 ♀, May 12, '11) (to Buckhannon River).  
Turbin's Run, seven miles above Buckhannon, Upshur Co., West Virginia. (Faxon) (to Buckhannon River).

**Kanawha drainage.**

Gauley River, Gauley Bridge, Fayette Co., West Virginia. (1 ♂ II, 1 ♀, May 8, '13).  
New River, Hinton, Summers Co., West Virginia. (1 ♂ I, Sept. 12, '12).  
Rich Creek, Spanishburg, Mercer Co., West Virginia. (Faxon) (to Bluestone and New Rivers).  
Pulaski, Pulaski Co., Virginia. (Faxon) (to New River).  
Reed Creek, Wytheville, Wythe Co., Virginia. (Faxon) (C. M., 2 ♀ ♀, Sept. 16, '12) (to New River).  
Blowing Rock, Watauga Co., North Carolina. (J. P. Moore, 1 ♂ I, 2 ♀ ♀, June, '93) (headwaters of New River).

**In Northeastern Kentucky.**<sup>43</sup>

"Smoky Creek," Carter Co., Kentucky. (Faxon).<sup>44</sup>

Little Hickman, Jessamine Co., Kentucky. (Faxon) (Kentucky River drainage).

**Cumberland drainage.**

Albany, Clinton Co., Kentucky. (Faxon) (to Cumberland River).

Small streams, Livingston, Rockcastle Co., Kentucky. (E. B. Williamson, 3 ♂ II, 1 ♀, June 21, '04) (to Rockcastle River).

Cumberland River, Orby, Bell Co., Kentucky. (2 ♂ I, 3 ♀, Sept. 10, '13).

Cumberland Gap, Bell Co., Kentucky. (Faxon).

Springs, Sparta, White Co., Tennessee. (1 ♂ II, 6 ♀, Aug. 26, '22) (banks of Calfkiller, to Caney Fork River).

Small run, Riverhill, White Co., Tennessee. (1 ♂ II, 2 ♀, Aug. 30, '22) (to Caney Fork River).

Hay's Branch, Burnside, Pulaski Co., Kentucky. (3 ♂ II, 1 ♀, Aug. 13, '23) (to South Fork Cumberland River).

New River, New River, Scott Co., Tennessee. (4 ♂ II, 2 ♀, Aug. 30, '24) (to South Fork Cumberland River).

**Tennessee drainage.**

Springs on bluff over Tennessee River, South Florence, Colbert Co., Alabama. (1 ♀, Aug. 26, '24).

Spring Creek, above Estill Springs, Franklin Co., Tennessee. (3 ♀, Aug. 19, '23).

Seven miles northwest of Chattanooga, Hamilton Co., Tennessee. (Faxon) (probably streams of Walden Ridge, to Tennessee River).

Spring, Charleston, Bradley Co., Tennessee. (1 ♀, Aug. 30, '14) (to Hiawassee River).

Spring, Athens, McMinn Co., Tennessee. (2 ♀, May 21, '15) (to Eastanaula Creek and Hiawassee River).

Small run, Murphy, Cherokee Co., North Carolina. (1 ♂ II, 1 ♀, Aug. 22, '22) (to Hiawassee River).

Small run, Wartburg, Morgan Co., Tennessee. (2 ♂ II, 3 ♀, Aug. 16, '23) (to Emory and Clinch Rivers).

Big spring, Dossett, Anderson Co., Tennessee. (2 ♀, Sept. 2, '14) (to Brush Fork Poplar Creek and Clinch River).

Powell River, Dryden, Lee Co., Virginia. (1 ♂ II, Sept. 7, '13).

South Fork Powell River, Big Stone Gap, Wise Co., Virginia. (2 ♂ I, 1 ♂ II, 2 ♀, May 15, '13).

<sup>43</sup>The following localities are somewhat doubtful, and may not refer to typical *bartoni*.

<sup>44</sup>Possibly = Smoky Valley in Tygart Creek drainage. See above under *C. propinquus sanborni*.

- Williams Creek, Liberty Hill, Grainger Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 15, '15) (to Clinch River).
- Dutch Valley Creek, Oakman, Grainger Co., Tennessee. (1 ♀, Sept. 14, '15) (to Clinch River).
- Clinch River, Fink, Russell Co., Virginia. (1 ♂ II, May 12, '13).
- Small run, Raven, Tazewell Co., Virginia. (1 ♂ II, 2 ♀ ♀, Sept. 21, '12) (to Clinch River).
- Fourmile Creek, Vonore, Monroe Co., Tennessee. (4 ♂ ♂ II, Aug. 29, '14) (to Tellico and Little Tennessee Rivers).
- Laurel Creek, Tellico Plains, Monroe Co., Tennessee. (2 ♂ ♂ II, May 22, '15) (to Tellico River).
- Pistol Creek, Rockford, Blount Co., Tennessee. (1 ♂ II, Sept. 4, '14) (to Little River).
- Little River, Cades Cove, Blount Co., Tennessee. (Faxon).
- Spring, Fountain City, Knox Co., Tennessee. (1 ♂ II, 3 ♀ ♀, and juv. Aug. 28, '14) (to Tennessee River).
- Spring, Bridgeport, Cocke Co., Tennessee. (1 ♂ II, 1 ♀, Sept. 3, '14) (to French Broad River).
- Waynesville, Haywood Co., North Carolina. (Faxon) (drainage of Big Pigeon River, to French Broad River).
- Black Mountain, Buncombe Co., North Carolina. (Faxon) (to Swananoa and French Broad Rivers).
- Montreat, Buncombe Co., North Carolina. (Faxon) (Flat Creek, to Swananoa River).
- Looking Glass Creek, Transylvania Co., North Carolina. (Faxon) (to French Broad River).
- Stoney Creek, Mohawk, Greene Co., Tennessee. (1 ♂ II, 7 ♀ ♀, May 18, '14) (to Lick Creek, Nolichucky, and French Broad Rivers).
- Small run, Chuckey, Greene Co., Tennessee. (1 ♂ II, May 19, '14) (to Nolichucky River).
- Nolichucky River, Erwin, Unicoi Co., Tennessee. (1 ♀, May 17, '14).
- Roan Mountain, Mitchell Co., North Carolina. (Faxon) (drainage of Toe River to Nolichucky River).
- Small run, Hilton, Scott Co., Virginia. (1 ♀, July 7, '13) (to North Fork Holston River).

## SUMMARY OF DISTRIBUTION AND ECOLOGY.

*C. bartoni bartoni* is distributed all along the Allegheny Mountains, from eastern Tennessee to Pennsylvania, and far beyond. It also extends to the Cumberland and Allegheny Plateau, but very little toward the Piedmont Plateau in the southern section of its range. Farther north, *i. e.*, from middle Virginia northward, it encroaches upon the latter. In Pennsylvania, for instance, it is everywhere. In the west, it is found chiefly in the eastern part of the Cumberland

Plateau, near the mountains, and farther north it extends widely over the Allegheny Plateau in Pennsylvania and eastern Ohio.

This means, that it is found in a number of different drainage systems, with a great tendency to become locally isolated. In consequence of this, it varies a good deal, and aberrant forms are frequently found, chiefly in its southern range.

This great variability and wide distribution is closely connected with its ecological preferences. This species is very rare in rivers of good size, but when found in them, is often at places where there are springs. It prefers creeks, small runs, and is most abundant in the uppermost headwaters of streams and in springs. It lives under stones, excavating holes, and often becomes more or less a burrowing form. In this case its holes open upon dry ground, but go down to the groundwater. These habits have favored the crossing over of divides by this form (actively or passively, see: Ortmann, '06, p. 448), and account for the fact, that the distribution is rather independent of the drainage lines.

Apparently, the original home of the typical *bartoni* is in the southern part of its present range, and here it still presents the greatest variability (see below). The typical form is always the one that lives in springs and small runs. In larger streams it is generally represented by aberrant types. Often these aberrant types appear as more primitive (for instance, the form of the upper Caney-Fork region, and those of the Great Valley in east Tennessee), possessing certain similarities to the *montanus*-group. Going northward, *bartoni* becomes more sharply defined. In the larger rivers (New and James Rivers), it is represented by *C. longulus*, which we consider a different species. It sticks rather closely to these drainage systems, and does not extend farther north, probably on account of its ecological habits. The typical *bartoni*, however, having a better opportunity to cross over divides because of its habitudinal preferences, migrated extensively northward. It was the form that was able to advance beyond the Potomac River, and acquire that general distribution in Pennsylvania (and beyond), without showing the excessive variability seen in the south. Only one striking form has been differentiated in the north (Lake Basin, chiefly), *C. bartoni robustus*. Possibly the latter is not a descendant of the typical *bartoni*, but represents rather a separate wave of migration, starting from more primitive forms that approached the older *montanus*-stock.

## TAXONOMIC REMARKS.

What we have to regard as the typical form of *bartoni*, are the crawfishes of this group found in eastern Pennsylvania, but this form, without appreciable change, has a much more extended range. It is characterized by the short and broad rostrum, with suddenly contracted margins, not forming sharp angles, and not being distinctly elevated, thus producing a rather flat upper surface. The acumen is comparatively short. The areola is moderately long (34-38 per cent of the carapace), and moderately wide (somewhat variable), with three or four, rarely more or less, distant and irregular dots in its narrowest part. The palm has only one row of tubercles on the inner margin (rarely traces of a second row). Generally these tubercles are weak, represented by mere serrations. The hand is covered by dots, which arrange themselves on the fingers in lines, forming furrows and ridges. The fingers are moderately long, sometimes somewhat gaping in large specimens, and are not subcylindrical. In the most cases they are not bearded, but traces of a beard may be present. The lateral spines of the carapace are typically absent, but in rare cases they may exist. The extraorbital angle is very variable, but usually present, and sometimes provided with a small spine.

Specimens representing the typical phase go very far south in the Allegheny Mountains. The southernmost localities, from which I possess such, are Athens, Tennessee, and Murphy, North Carolina; and in the southwestern direction, South Florence, Alabama. It is worth noticing, that all these came from springs or very small runs. *Individual* and *regional* variations are found corresponding to the great range, and the varying ecological conditions offered. Some of them have received names, which I am going to use (see below). But besides these, there are others, which, when regionally restricted, might also deserve names. I have refrained from naming them, because I do not want to add to the confusion already existing.

Additional cases of *individual* variation occurring among my material may be mentioned as follows:

a. Specimens with the rostrum more narrowed, longer, and with longer acumen, but in all other characters like true *bartoni*. Two males (II) belong here, one from the Clinch River at Fink, the other from Pistol Creek, at Rockford. Three specimens (out of five) from Wartburg also have this character (see below under two).

b. A male (I) from New River at Hinton, is a typical *bartoni*, but has the margins of the rostrum somewhat thickened, and the fingers

of the chelæ widely gaping and somewhat subcylindrical. These are characters of *longulus*, and I am inclined to think, in this case, of *hybridisation* with *longulus*, which is found in the same region. This, of course, is only conjectural.

The following forms are rather *regionally restricted*.

1. Three specimens (1 ♂ I, 2 ♀ ♀, from Blowing Rock, North Carolina) are typical *bartoni*, but have the tubercles on the inner margin of the palm more distinctly and strongly developed, thus they indicate an approach to the var. *asperimanus* (which see). In fact, they are transitional toward it, and are found near the home of *asperimanus*.

2. Specimens from three localities in the upper Cumberland drainage, the set from Livingston, Kentucky, from Orby, Kentucky, and from New River, Tennessee, and from one locality in the Emory drainage at Wartburg, Tennessee (3 ♀ ♀), resemble each other. The first set has been mentioned previously (Ortmann, in: Williamson, '05 p. 310). Here the rostrum is somewhat narrower and more tapering (but less so in the males from Wartburg), and the row of tubercles on the inner margin of the palm is quite distinct and sharp, with traces of a second row next to it. The rest, chiefly in the long areola, with three or four rows of irregular dots, are *bartoni*.

3. In the Great Valley in eastern Tennessee a form is frequently found which resembles *bartoni* in all respects, except that a trace of a second row of tubercles is seen on the inner margin of the palm. I have this form from Dossett, Charleston, Vonore, Tellico Plains, Mohawk, and Chucky. In every case, all specimens found at these localities were alike in this respect. The two males from Wartburg (mentioned above) would also belong here, while the three females fall under No. 2, so that this set again shows the variability of these characters.

4. In the headwaters region of Caney Fork, White Co., Tennessee, I have found two sets in springs and in a very small run (seven specimens at Sparta and three specimens at Riverhill), and one set in the headwaters of Elk River (three specimens at Estill Springs), which resemble, in the tubercles of the palm, the form just mentioned. Frequently (not always), in these a small lateral spine is present on the side of the carapace. In the specimens from Estill Springs this is well developed. It is interesting, that at least in the vicinity of Sparta (in Town Creek and in Calfkiller Creek at Amanda), the form *cavatus* is found which shows the same characters, however, the present specimens do not have the peculiar shape of the rostrum of *cavatus*.

A very similar form is from Burnside, Kentucky, but here the rostrum is a little more elongated. They are not identical with the upper Cumberland form described under 2, but form a sort of transition toward it.

It is very likely that certain localities reported for *C. bartoni* by Faxon (in southern Virginia and North Carolina) on the Piedmont Plateau, and those on the Cumberland Plateau ("Smoky Creek," Little Hickman, and Albany) do not have the typical *bartoni*. This, of course, cannot be decided without examination of the original material. I have not seen any specimens from Kentucky that represent the pure *C. bartoni bartoni*; all of them being more or less aberrant forms. The same holds good for central Tennessee, west of Cumberland Mountain and Walden Ridge. So much more astonishing is the fact, that at the locality which is the farthest in a southwesterly direction, South Florence, Alabama, and widely remote from the other localities, I found a genuine *bartoni*, (♀)! It was practically identical with the form from eastern Pennsylvania. But, this again was in a spring on the limestone bluff overlooking the Tennessee River.

Two local races of *C. bartoni* (*asperimanus* and *carinirostris*) have been distinguished by Faxon, which are recognizable. Since they have been named, they might very well be retained, although they are very restricted in their range, and are found within the area of, and in close vicinity to, *C. bartoni bartoni*.

### **Cambarus (Cambarus) bartoni asperimanus Faxon (1914).**

*C. bartoni asperimanus* FAXON, '14, pp. 391, 424.

*Type-locality*: Flat Creek, Montreat, Buncombe Co., North Carolina. (Faxon) (to Swananoa and French Broad Rivers).

#### ADDITIONAL LOCALITIES.

Swananoa River, Asheville, Buncombe Co., North Carolina. (1 ♂ II, May 13, '14).

Hominy Creek, Asheville, Buncombe Co., North Carolina. (1 ♀, Sept. 14, '14).

Pigeon River, Canton, Haywood Co., North Carolina. (1 ♂ I, 1 ♀, May 14, '14).

#### DISTRIBUTION AND ECOLOGY.

This form is restricted to the headwaters of French Broad River in the High Mountains of North Carolina. It should be remarked, that Hominy Creek, a tributary to the French Broad, undoubtedly has captured certain small tributaries of Pigeon River, and is preparing to capture this river altogether.

I found this form in rivers of moderate size and in a rather small creek, under stones, as usual.

## TAXONOMIC REMARKS.

According to Faxon, this form differs from *bartoni* as follows:

1. There are scattered coarse setæ upon the chelæ.
2. The chelæ are deeply and coarsely pitted, with a tendency toward corrugation.
3. The inner margin of the palm is furnished with a cristiform row of from five to seven teeth.
4. The dorsal surface of the carapace is extremely smooth, showing hardly a trace of the customary dots.
5. The epistoma is broadly truncate in front.

Faxon had two specimens (♂ ♂ I). My male, I, (Canton), has the characters listed under two and three, and, to a degree, that of four (dots poorly developed). But I do not see any setæ upon the chelæ, and the epistoma is triangular anteriorly. We know, that hairiness is a very elusive character, and that the anterior end of the epistoma is rather variable (within certain limits). But in this specimen, a very large and fine male, the character of the tubercles of the inner margin of the palm, and the general coarseness of the dots of the hand, is very striking, and so we have to take these as the main characters of the variety.<sup>45</sup>

The female, found with the above male, is smaller, and has these characters less distinctly developed, and might be taken simply for a normal *bartoni* with somewhat stronger tubercles on the palm. The male (II) from the Swananoa, Asheville, is intermediate in size between the two specimens from Canton, but shows the same characters of the hand as the male from Canton; in the rest of the characters, it is *bartoni*. Finally, the female from Hominy Creek is large, and in every respect like the male from Canton.

As has been said above, I have a male (I) and two females from Blowing Rock (in the headwaters of New River, some distance north-east of Asheville), in which the inner margin of the palm has the tubercles somewhat more strongly developed than is usual in *bartoni*. This indicates a transition toward *asperimanus*. However, I prefer to leave these with *bartoni*; the character being much less distinct here than in the specimens from Asheville and Canton.

<sup>45</sup>Specimens of *bartoni* from the upper Cumberland (Livingston, Orby, New River) approach *asperimanus* somewhat in the strong tubercles of the hand, but they have a more tapering rostrum. The rostrum of *asperimanus* is of the normal *bartoni*-type.

**Cambarus (Cambarus) bartoni carinirostris** Hay (1914).

*C. bartoni carinirostris* HAY, in: FAXON, '14, pp. 384, 423.

*Type-locality:* Gandy Creek, Osceola, Randolph Co., West Virginia. (Faxon) (tributary to Dry Fork of uppermost Cheat River).

ADDITIONAL LOCALITIES.

Albright, Preston Co., West Virginia. (Faxon) (on Cheat River).  
Shavers Fork, Parsons, Tucker Co., West Virginia. (1 ♂ II, 2 ♀ ♀, Aug. 2, '05) (to Cheat River).

Tygart Valley River, Elkins, Randolph Co., West Virginia. (Faxon).  
Tygart Valley River, Beverly, Randolph Co., West Virginia. (Faxon).  
Queens, Upshur Co., West Virginia. (Faxon) (on Middle Fork, to Buckhannon River).

West Fork Greenbrier River, Durbin, Pocahontas Co., West Virginia. (Faxon).

Laurel Creek, Greenville, Monroe Co., West Virginia. (Faxon) (to Indian Creek and New River).

DISTRIBUTION AND ECOLOGY.

This is a rather insignificant local variety of *bartoni*, found in rivers and creeks in the higher mountains of West Virginia, in the region where the headwaters of the Monongahela (Cheat, Tygart, and Buckhannon) and those of the Kanawha (Greenbrier) come together. The locality in Laurel Creek at Greenville, is a little more distant, but also belongs to the New-Kanawha drainage.

TAXONOMIC REMARKS.

This form differs from *C. bartoni bartoni* only in the presence of a light longitudinal median carina on the upper surface of the rostrum, toward the tip. In addition, the rostrum is very broad here, but this shape is often found also in *bartoni bartoni*.

I have collected three specimens of this form at Parsons, in the Cheat drainage, not far from the type-locality. It should be remarked, that specimens from Blackwater River (another tributary of the Cheat) at Davis, Tucker Co., West Virginia, are the typical *bartoni*, and not this form. In the headwaters of Buckhannon River (Hampton, and Turbins Run, Upshur Co.) normal *bartoni* is present.

**Cambarus (Cambarus) bartoni striatus** (Hay) (1902).

*C. latimanus* (var.) FAXON, '85a, p. 69;—FAXON, '85b, p. 359.

*C. latimanus striatus* HAY, '02b, p. 437;—FAXON, '14, pp. 395, 425.

*Type-locality:* Nashville, Davidson Co., Tennessee. (Hay)  
(Cumberland drainage).

## OTHER LOCALITIES.

**Cumberland drainage.**

Ashland, Cheatham Co., Tennessee. (Faxon).

**Tennessee drainage.**

Waterloo, Lauderdale Co., Alabama. (Faxon, '85b, p. 359).<sup>46</sup>

Keithly Branch (of Shoals Creek), Bailey Springs, Lauderdale Co., Alabama. (1♀, Aug. 25, '24)

Bridgeport, Jackson Co., Alabama. (Faxon).

Stream, mouth of Nickajack Cave, Shellmound, Marion Co., Tennessee. (Hay).

**Alabama drainage.**

Sand Mountain, Cullman, Cullman Co., Alabama. (Faxon).<sup>47</sup>

Blount Springs, Blount Co., Alabama. (Faxon).

## SUMMARY OF DISTRIBUTION.

The known localities are situated on the Cumberland Plateau, west of Walden Ridge (and its southern continuation), from northern Alabama to Tennessee. They belong to the Alabama, Tennessee, and Cumberland drainages, and all seem to be in small streams. If *C. graysoni* should belong here, the range would extend farther north, into the Green River drainage of Kentucky (see below). More information about the precise range and the ecological preferences is needed.

The specimen I collected (Bailey Springs) was in a small run. It was attracted by mussel-meat thrown into the water, when I cleaned Naiades, and thus noticed and captured. I could not discover another

<sup>46</sup>This locality, given by Faxon for the aberrant form of *latimanus*, which has later been called *striatus*, has disappeared from the locality-records of subsequent writers (Harris, '03, p. 106, and Hay and Faxon, *l. c.*). I do not know for what reason, since the next locality (Bailey Springs) is in the same vicinity, I let it stand.

<sup>47</sup>Sand Mountain is north of Cullman, forming the divide between the Tennessee and Black Warrior drainages.

individual, although a specimen of *extraneus* turned up at the same place. Hay found his specimens at Nickajack Cave "under stones in a small pool formed by the stream."

#### TAXONOMIC REMARKS.

The original description of this form is somewhat unsatisfactory. Faxon was the first to point out certain characters of it, but he believed it to be an aberrant form of *latimanus*. Hay, who elevated it to a variety of this species, described it chiefly in terms of comparison with *latimanus*. The main characters are the long and narrow areola, and the weaker tubercles of the hand. These two characters alone preclude any possibility of connecting it with *latimanus*. The shape of the rostrum is also not typically that of *latimanus*. In all of these characters it is more closely related to *C. bartoni*, but differs again from this rather strikingly, in the areola; as *bartoni* has a moderately long (34 to 38 per cent of carapace) and moderately wide (generally with three to five dots) areola. In the present form (according to my specimen),<sup>48</sup> it is 40 per cent of the carapace, and is very narrow in the middle, with only one or two irregular rows of dots.

The hand has been described as having a rather strong row of tubercles along the inner margin of the palm, and next to it ("just above it") another obscure row of much weaker tubercles. Although my specimen has rather small, regenerated, chelæ, the sculpture is exactly as described, and brings this form close to *bartoni* and not to *latimanus*. The fingers of the hand are said to be shorter (than in *latimanus*), but we know that there is a good deal of variation, in this respect, in *bartoni*.

Nothing whatever is said in the description of *striatus* about the granulations of the carapace, which are extremely strong and characteristic in *latimanus*. My specimen, however (length 77 mm.), being a rather large one, shows only the normal condition seen in *bartoni*; with granulations on the sides of the carapace, but not very strongly developed. A lateral spine is missing, as is generally the case in *bartoni*; while *latimanus* has small lateral spines. The extraorbital angle is present, but rounded.

In the description of the rostrum we find some statements that seemingly disagree. Hay says, that it is "perhaps a little broader to-

<sup>48</sup>Hay does not give measurements; he only says, that it is longer and "almost" reduced to a line in the middle.

ward the tip" (than in *latimanus*), while Faxon says, that the rostrum is narrower. In my specimen the rostrum is indeed narrower, with somewhat convergent margins, which rather suddenly contract into the acumen, forming an angle; the acumen has straight sides. *C. latimanus* has a rostrum, the margins of which converge slightly, and pass into the acumen in a rounded curve. The acumen itself has somewhat concave margins (see Faxon's figure, '85a, Pl. 2, fig. 3). This makes the acumen somewhat narrower in *latimanus*, but broader in *striatus*, and possibly Hay's statement refers to this character. Yet, at the best, this is only a minor, and probably variable, character.

The armature of the carpopodite of the chelipeds shows a strong median, and a small proximal internal spine, and a rather blunt spine in the middle of the anterior lower margin. This does not offer any peculiarities. In my specimen, with regenerated chelipeds, these spines are present, but blunt and not large.

The general shape of the carapace of my specimen is slightly different from both *latimanus* and *bartoni*. It is not so distinctly depressed, but more subcylindrical, or rather subquadrangular. The upper surface is flattened and rather broad, and the sides are nearly vertical, exactly as described by Faxon ('14, p. 393) for *C. graysoni*. The carapace, however, has not that compressed shape seen in the *diogenes*-section, where the flat part of the upper surface is considerably narrower, passing more gradually into the vertical sides.

The species just mentioned, *C. graysoni* Faxon ('14, pp. 393, 425) is very likely the same as *striatus*. I cannot find any differences in the description given by Faxon from that of *striatus*, nor from my specimen, except that the rostrum is "short," and the acumen "upturned," which sounds somewhat different from *striatus*. This cannot be made out with certainty in view of the absence of figures of either form. The areola of *graysoni* is long, nearly as long as in my specimen of *striatus* (38.9 per cent in *graysoni*, 40 per cent in *striatus*), and is narrow, with only two rows of dots. The armature of the carpopodite and of the hand is the same, and the description of the shape of the carapace exactly fits my specimen. Faxon mentions a peculiar articulation of the hand with the carpus, which makes the former "assume a vertical position when flexed and to form with its fellow a shield or operculum appressed to the front of the body." He considers this "a sure token of the burrowing habits of this species." I do not understand this sentence. The typically burrowing species (*diogenes*-sec-

tion) hardly differ in the articulation of the carpopodite and hand from the forms of the *bartoni*-group. We also know that the latter are, more or less, habitual burrowers, though not so decidedly as the regular "chimney builders." Faxon himself admits the affinity of *graysoni* to *C. latimanus*, including the form *striatus*.

*C. graysoni* is from Bear Creek, Grayson Springs, Grayson Co., Kentucky, a tributary to Green River. If it actually is identical with *striatus*, the distribution of the latter would extend somewhat farther northward on the Cumberland Plateau.

**Cambarus (Cambarus) bartoni laevis** Faxon (1914).

*C. bartoni* HAY, '96, p. 487, fig. 6.

*C. bartoni laevis* FAXON, '14, pp. 391, 424.

*Type-locality*: Bloomington, Monroe Co., Indiana. (Faxon).

KNOWN LOCALITIES.

**In southern Indiana.** (Ohio and Wabash drainages).

Falls Creek, Indianapolis, Marion Co., Indiana. (Hay).

Irrington, Marion Co., Indiana. (Hay).

Bloomington, Monroe Co., Indiana. (Faxon, type-locality).

May's Cave, Monroe Co., Indiana. (Hay).

Mayfield's Cave, Monroe Co., Indiana. (Faxon).

Clear Creek, Monroe Co., Indiana. (Hay).

Mitchell Caves, Lawrence Co., Indiana. (Faxon).

Entrance of caves, Mitchell, Lawrence Co., Indiana. (Ferd. Payne and Newton Miller. 3 ♂♂ I, 9 ♂♂ II, 9 ♀♀, Aug., 1906).

Down's Cave and Conelly's Cave, Lawrence Co., Indiana. (Hay).

Paoli, Orange Co., Indiana. (Hay).

New Albany, Floyd Co., Indiana. (Hay).

**South of Ohio River.**

Lexington, Fayette Co., Kentucky. (Shull, '09, p. 301) (Kentucky drainage).<sup>49</sup>

Springs, Milton, Cabell Co., West Virginia. (3 ♂♂ II, 1 ♀, Sept. 30, '11) (Guyandot drainage).

Springs, Poca, Putnam Co., West Virginia. (1 ♂ II, May 9, '13) (Kanawha drainage).

<sup>49</sup>This should be confirmed. Shull mentions this as *C. bartoni*, similar to the Indiana form.

## SUMMARY OF DISTRIBUTION.

This form is most abundant in southern Indiana, but it is also probably found in northern Kentucky. The latter region is yet very poorly known with regard to its crawfish-fauna. The presence of this form in these parts is made probable by the fact, that I discovered it in western West Virginia. Thus it would be an inhabitant of the northern section of the Cumberland Plateau, in the Ohio drainage, extending across the Ohio River into southern Indiana.

The ecology has been discussed by Faxon. It is found in cave-waters and surface-waters of various character. My West Virginia specimens, however, were dug out of holes in, and close to, springs.

## TAXONOMIC REMARKS.

This form is closely allied to *C. bartoni striatus*, and may only be a somewhat smoother, northern form of it. According to the description and figure given by Hay, according to Faxon's account, and my specimens from southern Indiana (Mitchell), there are only the following differences.

1. The whole carapace is smoother, i. e., the dots are less distinct, and the granulations, chiefly on the branchial regions, are very weak; only on the hepatic regions are they distinct.

2. The rostrum is more like that of typical *bartoni*. The shape figured by Hay (fig. 6 (1) ), is actually found, but often the whole rostrum is shorter, and chiefly the acumen is shorter. The latter always has slightly concave margins, and the angles at its base are rounded. These differences are, however, very slight. My material from Mitchell (twenty-one specimens) shows considerable variation, and some specimens have a rostrum as figured by Hay. This shape also comes extremely close to that seen in my only specimen of *striatus*.

3. The armature of the chelipeds is practically the same as in *striatus*, only, in my specimens, the two rows of tubercles on the inner margin of the palm are not very sharp, but blunt, although well visible. Hay describes "a series of blunt serrations," while Faxon says that this margin is "more distinctly tuberculate" (than in the normal *bartoni*). Thus it seems, that this character is somewhat variable.

I cannot see any other differences, and some of the essential characters are alike in both forms. The carapace has the same sub-quadrangular shape, mentioned under *striatus* (and described by Faxon for *graysoni*), and the areola is practically the same. Its length is 41 per cent of the carapace according to Hay, and 42 per cent according to Faxon. About the same proportions are found in my specimens.

It is also narrow, having in the middle, room for not more than two dots.

My specimens from West Virginia (4 ♂♂ II, 1 ♀) have the comparatively smooth carapace and the long, narrow areola of *laevis*. In some of them, the areola is exactly as in *laevis*; but its length varies between 37 and 41 per cent. In one specimen, it is slightly wider, containing three rows of dots. The rostrum is more like that of typical *bartoni*, i. e., rather short, with shorter acumen, but this shape is also found in some specimens from Indiana. The chelipeds have the inner margin of the palm provided with "a series of blunt serrations," as described by Hay, and not the double row of low tubercles seen in my specimens from Indiana. It is not astonishing, however, to find differences like this in a set that comes from a locality so remote from the original one.

*C. bartoni striatus* and *C. bartoni laevis* are thus extremely closely allied, and might be actually identical. I do not unite them for the reason, that I have only a single individual of *striatus*, with the chelæ possibly not typical (regenerated). According to what has been said above, *striatus* has a rougher carapace, and stronger sculpture on the chelæ, and has a somewhat more elongated rostrum; while *laevis* is smoother, has weaker tubercles on the chelæ, and a somewhat shorter rostrum. Additional material may show that the two forms pass into each other, or, that the differences are only individual.

There is no doubt, that these two forms of *bartoni* constitute the transition from this species to the crawfishes of the *diogenes*-section. The latter have a still narrower areola, and the carapace is decidedly more compressed, and has the flattened dorsal area narrower. The geographical distribution of these two forms, on the Cumberland-Allegheny Plateau, is significant. The range is in close contact with, or in the vicinity of, those parts which we are to consider as the original home of the *diogenes*-section, namely, the Great Valley of eastern Tennessee, and the mountains to the east and west of it (see below).

### **Cambarus (Cambarus) bartoni tenebrosus** Hay (1902).

*C. bartoni tenebrosus* HAY, '02a, p. 232;—FAXON, '14, p. 424.

*C. tenebrosus* GARMAN, '20, p. 42.

*Type-locality*: Mammoth Cave, Edmonson Co., Kentucky. (Hay).

"And other underground streams in Kentucky" (Garman).

This form differs from *C. bartoni* in the eyes, which are reduced in size, in the longer areola, in the presence of lateral spines on the carapace, and in the longer antennæ.

According to Garman, this is entitled to specific rank for the reason that it does not intergrade with *bartoni*, which is a valid reason; and because the latter, "does not occur in some localities in which this small-eyed species is found," which is not convincing.

Before we decide this question, we should know more about the actual affinities of *tenebrosus* to *bartoni*, morphological and distributional. It should also be pointed out, that we have no records for the true *bartoni* from the Mammoth Cave region. Some of its local forms or varieties apparently exist here (*graysoni*, which may be the same as *striatus*), or are found at no great distance (*striatus* to the south, *laevis* to the north), but *bartoni bartoni* is not found till we come to the upper Cumberland drainage in Kentucky. Even here it is represented by peculiar forms (see above).

Forms resembling *striatus* or *laevis* are to be expected in surface waters in the Mammoth Cave region, and we know, that at least *laevis*, has, in southern Indiana, a strong tendency to enter cave-waters. Just these two forms only possess one of the characters of *tenebrosus*, the long areola. Unfortunately, no measurements (except total length) have been given for *tenebrosus*, and so we are compelled to let the matter rest, until we obtain further information.

#### 4. SECTION OF *C. DIOGENES*.

Carapace ovate, compressed, and without lateral spines. Rostrum without marginal spines. Chelæ short, ovate, broad, and depressed. Areola very narrow or obliterated (linear) in the middle, always distinctly longer than one third of the carapace. Eyes well developed.

The essential characters distinguishing this section from that of *bartoni* are found in the compressed shape of the carapace and the very narrow areola. The flattened part in the middle of the carapace is rather narrow, and the sides of the carapace curve down from it decidedly and then become vertical. The narrow areola is foreshadowed by the areola of certain *bartoni*-forms (*striatus*, *laevis*), but reaches its maximum here. In some cases, where the two lines bordering the branchial regions do not meet in the middle, a very narrow areola is still present, leaving room for hardly more than one row of dots. In other (typical) cases, these lines meet in the middle, forming a single line, so that the areola is here obliterated (linear).

Two species belonging here are found in our region, but I give a key for three; the third (*monongalensis*) being closely allied to one of them. This is also advisable, because I entertain views as to their taxonomy different from those published by Faxon ('14).

- a. Areola very narrow (but not obliterated), with 0—1 rows of dots. Rostrum short, not lanceolate nor elongated. Color, in life, peculiar, bright red or blue, rarely dull slate-blue.
  - b. Rostrum broad, acumen rather distinctly defined. Outer margin of hand subserrate, somewhat keeled. Color slate-blue, bright blue, or bright red..... *C. carolinus*.
  - b<sub>1</sub>. Rostrum narrower, shorter, acumen indistinctly defined. Outer margin of hand rounded. Color bright blue..... *C. monongalensis* (extralimital).
- a<sub>1</sub>. Areola linear, obliterated in the middle, if very narrow, there is hardly any room for dots. Rostrum somewhat elongated, mostly sublanceolate, not broad and short. Color brownish or greenish olive, very rarely red (as individual or regional variation)..... *C. diogenes*.

### **Cambarus (Cambarus) carolinus** (Erichson) (1846).

*Astacus (Cambarus) carolinus* ERICHSON, '46, p. 96.

*Cambarus carolinus* HAY, '02c, p. 38;—HARRIS, '03, p. 81;—ORTMANN, '05a, p. 393.

*C. (Bartoni) carolinus* ORTMANN, '05b, pp. 120, 135;—ORTMANN, '06, p. 394, Pl. A, fig. 4, Pl. 39, figs. 3a, 3b, 9, Pl. 40, fig. 4.

*C. carolinus carolinus* FAXON, '14, pp. 396, 399, 425.

*C. dubius* FAXON, '84, p. 114;—FAXON, '85a, p. 70, Pl. 4, fig. 3, Pl. 8, fig. 7;—UNDERWOOD, '86, p. 368;—FAXON, '90, p. 624;—HAY, '99, pp. 959, 965.

*C. carolinus dubius* FAXON, '14, pp. 399, 425.

*Type-locality:* Greenville, Greenville Co., South Carolina. (Erichson, Faxon) (on Piedmont Plateau).

#### ADDITIONAL LOCALITIES.

##### **Piedmont Plateau.**

Swampy ground near springs, Marion, McDowell Co., North Carolina. (2♀ ♀, May 16, '14).

##### **High Mountains.**

Cherokee Co., North Carolina. (Faxon)<sup>50</sup> (Hiawassee-Tennessee drainage).

<sup>50</sup>I thus transcribe Faxon's ('90) record: "among the Cherokees." Faxon himself ('14) says that this is probably in Swain or Jackson Co., (close to Cherokee Co.). I have seen, at Murphy, Cherokee Co., crawfish-chimneys, and tried unsuccessfully to dig out specimens (too many large rocks). The owner of the place told me, that these were *red* crawfishes, and thus probably this species. I traced chimneys, supposed to belong here, even farther South, to Blue Ridge, Fannin Co., Georgia, but had no chance to obtain specimens.

Swamp, Asheville, Buncombe Co., North Carolina. (1♀, May 10, '15) (French Broad drainage).

Blowing Rock, Watauga Co., North Carolina. (Ortmann) (headwaters of New-Kanawha).

**Allegheny Valley and Mountains, between High Mountains and Cumberland Escarpment.**

Swampy ground near springs, Barron, Washington Co., Virginia.

(1 ♂ II, 3 ♀ ♀, May 19, '13) (upper Holston).

Springs, Gate City, Scott Co., Virginia. (1 ♂ II, May 16, '13) (upper Holston).

Springs, Speers Ferry, Scott Co., Virginia. (2 ♂♂ II, July 8, '13) (Clinch drainage).

Springs, Cleveland, Russell Co., Virginia. (1 ♂ II, 2 ♀ ♀, May 13, '13) (Clinch drainage).

Pennington Gap, Lee Co., Virginia. (Faxon) (Powell drainage).

Cumberland Gap, Claiborne Co., Tennessee. (Faxon) (Powell drainage).

**Allegheny Plateau in West Virginia.**

The localities given by Faxon ('14) should be quoted as follows.

Squirejim, McDowell Co., West Virginia. (Faxon) (headwaters of Big Sandy).

Yukon, McDowell Co., West Virginia. (Faxon) (headwaters of Big Sandy).

Baileyville, Wyoming Co., West Virginia. (Faxon) (Guyandot drainage).

Lashmeet, Mercer Co., West Virginia. (Faxon) (New River drainage).<sup>51</sup>

Northward, no localities are known till we come to northern West Virginia, but the species probably is present all along the western side of the mountains, on the Plateau. Localities in West Virginia are:

Swampy ground, Elkins, Randolph Co., West Virginia. (2 ♂♂ II, May 11, '11) (Tygart-Monongahela).

Parsons, Tucker Co., West Virginia. (Ortmann) (Cheat-Monongahela).

Terra Alta (= Cranberry Summit), Preston Co., West Virginia. (Faxon, *type-locality* of *C. dubius*) (divide between Cheat and Youghiogheny, to Monongahela).

Reedsville, Preston Co., West Virginia. (Ortmann) (Decker's Creek, to Monongahela).

<sup>51</sup>I have seen numerous chimneys, probably belonging to this species, near Princeton, Mercer Co., West Virginia, but did not collect specimens.

Coopers Rock, Mount Chateau, Monongalia Co., West Virginia. (1 ♀, Aug. 7, '12) (to Cheat).  
Schell, Mineral Co., West Virginia. (Ortmann) (Potomac drainage, but West of Allegheny Front).

Further, this species goes through western Maryland into southwestern Pennsylvania (see: Ortmann, '06). A new locality should be added:

Humbertston, Fayette Co., Pennsylvania. (A. K. Hampshire. 1 ♂ I, 1 ♂ II, 5 ♀ ♀, March 29, '07), (Chimneys seen at Hooversville, Somerset Co., Pennsylvania, surely belong to this species).

#### SUMMARY OF DISTRIBUTION.

It seems that the above records, although somewhat incomplete, give an adequate idea of the range of this species, which is *extremely peculiar*. From the High Mountains, formed by the southern extremity of the Blue Ridge, in North Carolina (possibly as far south as northern Georgia), and the Piedmont Plateau. Just at the foot of the mountains, in South and North Carolina, the range swings over into the headwaters region of the Tennessee River, and across the Allegheny Mountains to the Cumberland-Allegheny Plateau in southern West Virginia. To the north exists a gap, probably due to defective knowledge, but in northern West Virginia, this species is again present on the Allegheny Plateau, on the part close to the Allegheny Front, and continues northward as far as Pennsylvania (in Fayette, Somerset, and Westmoreland Cos.; for particulars *See*, Ortmann, '06, p. 451). Thus, generally speaking, *C. carolinus* is a mountain-species, but is not found everywhere in the mountains.

It should be mentioned, that Faxon ('14) gives this species also from "a tributary of Stone River twenty miles from Columbia (Maury Co.) in central Tennessee." No tributary of Stone River is anywhere within twenty miles from Columbia (nearest part of this drainage is about thirty miles northeast of Columbia), and this locality, disregarding the fact that *C. carolinus* is not found in *streams*, is very vague. Moreover, these specimens are very probably not *carolinus*, but *diogenes* (see below).

This is a burrowing species and a chimney builder, found in swampy ground in and near *cool* springs. All specimens collected by myself were dug out of burrows. (As to general ecological preferences, compare Ortmann, '06, p. 416 *et seq.*).

## TAXONOMIC REMARKS.

Faxon ('14) distinguishes three varieties within this species. One is *C. carolinus monongalensis*, here treated as a species. The other two are very closely connected, and are said to differ from each other in the following characters.

*C. carolinus carolinus*. Rostrum moderately broad, with distinctly convergent margins, forming rounded angles at base of acumen. Outer margin of hand rounded, not serrated. More than one spine on inner margin of carpopodite of first peræopods.

*C. carolinus dubius*. Rostrum broader, with nearly parallel margins, forming sharper angles at base of acumen. Outer margin of hand subserrate. Only one spine on inner margin of carpopodite of first peræopods.

Of *C. carolinus carolinus*, which is found in North and South Carolina, Faxon had only one specimen, and photograph and drawings of the type-specimen. Also my material is not very rich, but I have two ♀♀ from Marion, and one ♀ from Asheville, from the general region where this form should be expected. From these, however, I have been able to ascertain that the characters given by Faxon do not hold good. The specimen from Asheville, and the smaller one from Marion, have the rostrum as described (with convergent margins and rounded lateral angles), but the larger specimen from Marion distinctly has the rostrum of the *dubius*-type. The outer margin of the hand, in all three specimens, has a slight indication of a ridge, subserrated by a row of dots, but not so well developed as in *carolinus dubius* from Pennsylvania. The armature of the inner margin of the carpopodite is quite variable. The Asheville specimen corresponds to Faxon's description of *carolinus carolinus*. The larger one from Marion differs in the right and left cheliped, having two spines on the right, of which, however, the smaller stands anterior to the larger (normal) one, and posterior to the latter is a tubercle. On the left cheliped there is only one spine and two sharp tubercles. The smaller specimen from Marion has only one spine on either side and two tubercles.

In addition to these, I have collected four ♂♂ II, and five ♀♀ at four localities in the upper Holston and Clinch drainages in Virginia. This largely fills out the gap between the range of "*carolinus*" in North Carolina and that of "*dubius*" in West Virginia and northward. Some of these specimens have the rostrum of the *dubius*-type (sharp angles at base of acumen). In others the margins are more convergent

and the angles are rounded off, with all transitional conditions. The outer margin of the hand is more or less subserrate, and the spines on the inner side of the carpopodite are again very variable. Rarely there are two spines, usually only one, with one or two tubercles which may be weak or sharp (condition seen in *dubius* from Pennsylvania).

Thus it is clear, that in specimens from North Carolina the characters of *carolinus carolinus* as given by Faxon, are not always found, and, on the other hand, that specimens from northern Virginia lead to the typical condition seen in the northern *dubius*. No sharp line can be drawn between them, and the only feature that deserves attention, is the fact, that the tendency to have the *carolinus*-type of rostrum prevails in the southern part of the range. But even here, occasionally, the *dubius*-type is found. Thus all of these characters are merely individual.

The colors exhibited by these crawfishes are very interesting. Faxon, having only preserved material, was unable to say much about them. All specimens, however, collected by myself, were dug out alive and the colors noted. In the northern part of the range, in Pennsylvania, Maryland, and northern West Virginia, the color is always red (see Ortmann, '06); the same color I observed in three specimens dug out at Cleveland (Clinch Valley), and in the one specimen from Asheville. The specimens from Speers Ferry, Gate City, and Barron, were blue, exactly like *C. monongalensis* of southwestern Pennsylvania. Finally, the two specimens from Marion, on the Piedmont Plateau, had a peculiar slate-blue color, rather dull, and not, by any means, as vivid as the red and blue ones. There was, however, no indication of the brownish or greenish olive tints usually seen in crawfishes. My material is too meagre to draw any conclusions from these records, but attention should be paid to this (color) in the future, and the distribution of the different color-types ascertained.

Of the southern form, my largest male (II, from Speers Ferry) is 59 mm., long; my largest female (Marion) 52 mm.

In the three specimens mentioned above as recorded by Faxon from central Tennessee, certain peculiar characters have been pointed out, chiefly the narrow rostrum with less abrupt acumen, and the very narrow areola reduced "to a narrow line." This leads me to believe that these specimens are actually *C. diogenes*. I have a specimen of the latter from central Tennessee (Raus, Bedford Co.), which could very well answer the description of Faxon's specimens, as far as it goes, and

which resembles *carolinus* in one particular point, the inner margin of the palm has only one row of distinct tubercles. In all other respects, and in color also, it is a *diogenes*, and *not* a *carolinus* (see below).

***Cambarus (Cambarus) monongalensis* Ortmann (1905).**

*C. dubius* WILLIAMSON (not FAXON), '01, p. 11.

*C. monongalensis* ORTMANN, '05a, p. 395.

*C. (Bartoniuss) monongalensis* ORTMANN, '05b, p. 120;—ORTMANN, '06, p. 398, Pl. B, fig. 4, Pl. 39, figs. 4a, 4b, 10, Pl. 40, fig. 5.

*C. carolinus monongalensis* FAXON, '14, pp. 399, 425.

This form is not found in the region under discussion, but is more northern. It is shortly introduced here, to set forth its relation to *C. carolinus*. The differences pointed out by me ('06) hold good in every case, the rostrum, armature of carpopodite and meropodite being always different from *C. carolinus* in its southern as well as in its northern phase. In color only, are some southern *carolinus* like *monongalensis*, but in every other detail these blue *carolinus* are true *carolinus*. *C. monongalensis* is always blue, and other shades have never been observed. In Pennsylvania as well as in West Virginia, there is no evidence of any intergrading of the two species.

This species belongs to the Allegheny Plateau in southwestern Pennsylvania and northern West Virginia (for particulars see: Ortmann, '06). I should like to add here an unpublished new locality, which is the most southern known:

Burnsville, Braxton Co., West Virginia. (1 ♂ II, May 24, '11) (Little Kanawha drainage).

***Cambarus (Cambarus) diogenes* Girard (1852).**

For references see:

*C. (Bartoniuss) diogenes* ORTMANN, '06, p. 402, Pl. A, fig. 3, Pl. 39, fig. 11, Pl. 40, figs. 6, 7, in addition:

*Bartoniuss diogenes* WILLIAMSON, '07, p. 760.

*Cambarus diogenes* HANKINSON, '08, p. 233;—PEARSE, '10a, p. 74;—PEARSE, '10b, p. 20;—PEARSE, '13, p. 4;—FAXON, '14, pp. 400, 426.

*C. (Bartoniuss) diogenes* GRAENICHER, '13, p. 122.

*Type-locality*: Washington, D. C. (Girard).

**DISTRIBUTION.**

The distribution of this species, as known hitherto, is largely extralimital to our region. I shall give here only a rough sketch,

mentioning only such special localities as are apt to have certain relationships to our area.

The eastern form of *diogenes* belongs to the Atlantic Coastal Plain from New Jersey to North Carolina.<sup>52</sup> The western form goes from western Pennsylvania through the states north of the Ohio (northward to Michigan, Wisconsin, and Minnesota) to the Mississippi River, and beyond (to Nebraska and Colorado). South of the Ohio, comparatively few localities are known in *northern West Virginia*, and the most southern of these (on the Allegheny Plateau) is a new one, as follows:

Buckhannon, Upshur Co., West Virginia. (3 ♀ ♀, May 12, '11).

From *Kentucky*, it has been reported from the following places: Louisville, Jefferson Co., Kentucky. (Faxon) (Ohio valley).

Beespring, Edmonson Co., Kentucky. (Faxon) (Cumberland Plateau, Green River drainage).

Mammoth Cave, Edmonson Co., Kentucky. (Faxon) (do.).

In addition, there are localities known in *Mississippi, Alabama, and Louisiana*. The following are from the first two states:

Mulden, Monroe Co., Mississippi. (Faxon) (Cretaceous Mississippi Embayment, Tombigbee drainage).

Agricultural College, Oktibeha Co., Mississippi. (Faxon) (do.).

Monticello, Lawrence Co., Mississippi. (Hagen) (Tertiary Gulf Coastal Plain, Pearl River drainage).

Auburn, Lee Co., Alabama. (Faxon) (southern extremity of Piedmont Plateau).<sup>53</sup>

These southern localities stand rather isolated, and moreover, there was, before this, no connection of the western-southern range with the eastern, no localities having been reported from the states of Tennessee, Georgia, and South Carolina. I am, however, able to fill out this gap, at least in part, by the following localities in *Tennessee*.

<sup>52</sup>New localities are:

New Altona Beach, Anne Arundel Co., Maryland (1 ♀, Sept. 6, '25).

Pilkinton, Powhatan Co., Virginia (1 ♀ juv., Aug. 24, '25).

At the former place, I found it in close vicinity to salt (or brackish) water of Stony Creek, hardly a foot over high tide level. The other locality is remarkable for the fact that it is on the *Piedmont Plateau*, and not on the Coastal Plain. Here it was in burrows along muddy and swampy banks of a small stream tributary to Appomattox River.

<sup>53</sup>The var. *ludovicianus* Faxon is known from Louisiana, and from Rosedale, Bolivar Co., Mississippi (Faxon) (Mississippi Bottoms).

**Mississippi Bottoms.**

Banks of Bayou de Chien, Walnut Log, Obion Co., Tennessee. (1♀ juv., Aug. 13, '24).<sup>54</sup>

**Mississippi Embayment (Cretaceous).**

Big Sandy Bottoms, Hollow Rock Junction, Carroll Co., Tennessee. (1♀, Aug. 19, '24).

**Cumberland Plateau.**

Raus, Bedford Co., Tennessee. (1 ♂ II, Aug. 20, '23) (Central Basin). Clifty, Cumberland Co., Tennessee. (1 ♂ II, Aug. 28, '22).

**Great Valley of Eastern Tennessee.**

Harriman, Roane Co., Tennessee. (2 ♂ ♂ II, May 16, '15) (foot of Walden Ridge).

Dossett, Anderson Co., Tennessee. (1♀, Sept. 2, '14) (foot of Walden Ridge).

Athens, McMinn Co., Tennessee. (1 ♂ I, 1♀, May 21, '15).

Tellico Plains, Monroe Co., Tennessee. (1 ♂ I, May 22, '15) (foot of High Mountains).

Vonore, Monroe Co., Tennessee. (1♀, May 14, '15).

Fountain City, Knox Co., Tennessee. (1♀, Aug. 28, '14).

Mohawk, Greene Co., Tennessee. (1 ♂ II, 1♀, May 18, '14).

These new localities indicate an apparently continuous area, which, however, is not very closely connected with the older records. Chiefly the connection toward the Alabama locality (Auburn) is missing, and more information is needed from central Tennessee. It is perfectly clear, then, that my locality at Hollow Rock Junction, in western Tennessee, is to be grouped with the localities, Mulden and Agricultural College in Mississippi, being situated on the same geological formation (Cretaceous belt of Mississippi Embayment). The localities in the Great Valley form a distributional unit, covering the whole width of the valley, and going northward to Greene Co. (northeast of Knoxville).<sup>55</sup>

Additional records are also wanted in Kentucky, which may demonstrate, that the localities in central Tennessee are connected in a northwesterly direction, with the main western range of the species in the states north of the Ohio.

Evidently there is no connection, of the area in the Great Valley,

<sup>54</sup>This young specimen probably belongs to the var. *ludovicianus* Faxon.

<sup>55</sup>Beyond this, in the headwaters of the Tennessee, *C. carolinus* is the burrowing crawfish.

with the eastern range, beginning in the Coastal Plain of North Carolina, as the mountains (and the Piedmont Plateau) have *C. carolinus* as the burrowing species. Thus the eastern *diogenes* is still separated from the localities in eastern Tennessee and Alabama (Auburn). The states of Georgia and South Carolina should be searched for it.

Below the fact will be brought out, that the Tennessee-*diogenes* morphologically connects the eastern and western race of the species, and thus it is suggested, that it represents the original stock, from which the others descended, and that its area probably represents the center of radiation of this form. This is also supported by the fact, that, in this region, *diogenes* is in close proximity to the range of the species most closely allied to it, namely *C. carolinus*, and to the supposed original home of the *bartoni*-section, and that of the subgenus of *Cambarus* in general, where we are to look for the forms, which are ancestral to *diogenes*.

*C. diogenes* is a burrowing species (chimney builders), living in swampy ground. All my specimens were dug out of holes, with the exception of the one from Clifty. This was found in a small stream, badly charged with mine-water, in a dying condition. Probably it was not living in the stream, but had strayed into it by accident.

Males of the I form were found in May, and females with eggs in the same month (at Buckhannon, West Virginia).

#### TAXONOMIC REMARKS.

*C. diogenes* is distinguished from *C. carolinus* by the areola, which is, in most cases, obliterated in the middle (linear), and by the rostrum, which is narrower, more or less lanceolate, with an indistinct, or poorly marked acumen; by certain characters of the chelæ (more sculptured), and the color, which, with rare exceptions to be mentioned below, is of the usual tints seen in crawfishes (greenish or brownish olive).

Since the new localities here recorded from Tennessee are intermediate between the eastern and western range of the species, it is desirable to examine my material more closely, in order to ascertain its relation to the two forms. <sup>56</sup>

I have pointed out (Ortmann, '06, p. 407) certain differences between

<sup>56</sup>In the following discussion the specimen from Hollow Rock Junction, western Tennessee, is not considered, since it unqualifiedly represents the western form. The specimen from Walnut Log is young, but probably of the var. *ludovicianus*.

the eastern and western form of *diogenes*.<sup>57</sup> They are as follows:

1. Areola in the western form is more frequently not-entirely-obiterated, than in the eastern.

2. Rostrum, in the western specimens, with a tendency to obscure the acumen, so as to make the whole rostrum rather regularly lanceolate. In eastern specimens, the acumen is more distinct.

3. Chelæ, with the fingers proportionally longer in the eastern form, and the inner margin of the palm shorter. The latter, in the eastern form always with two rows of tubercles; in the western, there are one or two rows, and additional scattered tubercles on the upper surface of the palm. In the eastern form, the teeth of the cutting edge of the dactylopodite are interrupted near the base by a slight excision (as if one of the teeth had been suppressed). This character is missing in the western form.

With regard to these characters, the Tennessee-specimens are truly intermediate. A few of them (from Mohawk, Vonore, Tellico Plains) are the western form in every respect, while some others (Dossett, Harriman) closely approach the eastern in areola, rostrum, shape and armature of hand, but the excision at the base of the inner edge of the dactylopodite is missing. The rest have some characters of the western, and some of the eastern form. The hand has rather long fingers, the inner margin of the palm has two rows of tubercles, with only a few small ones near the base of the dactylopodite, and the rostrum has a well defined acumen (eastern characters). The areola, however, is mostly not-entirely-obiterated, and in one case (Clifty), it is narrow, but wide enough for one row of dots. Further, the excision at the base of the moveable finger is always absent (western character). In one case (Raus), there is only *one* row of tubercles on the inner margin of the palm, with one or two additional tubercles of a second row.<sup>58</sup>

Thus it is clear that the Tennessee-specimens are intergrading be-

<sup>57</sup>There is another difference in the color of the newly-laid eggs, which are buff in the western form, but blackish in the eastern. This was first pointed out by Andrews ('07, p. 263), and subsequently confirmed by myself. I cannot use this character here, since I did not find specimens with eggs in Tennessee.

<sup>58</sup>This specimen, in this character, resembles *C. carolinus*, and I suspect that specimens of *carolinus* (*dubius*) mentioned by Faxon ('14, p. 397) from central Tennessee actually belong here. For the characters of the narrower rostrum, with less distinct acumen (as compared with *carolinus*), and the narrow areola ("reduced to a narrow line") agree rather with *diogenes* than with *carolinus*. My specimen from Raus has the areola obliterated in the middle, forming only *one* line, and the rostrum is of the type of the eastern *diogenes*.

tween the eastern and western *diogenes*. Some are purely western; others more or less closely approach the eastern type, without, however, fully corresponding to the latter.

In *color*, the Tennessee crawfishes of this species are generally normal, having the greenish or brownish olive tints as are found elsewhere. In one case (Raus), the ground color has been recorded as "dark green, almost black." However, at the eastern foot of Walden Ridge, at Harriman and Dossett, all specimens found (2 ♂♂ II, 1 ♀) had a *reddish* ground color. While the female from Dossett has been recorded as completely "bright red," the males from Harriman are recorded as, "body olive-brown to reddish-brown (on carapace); rostrum and chelæ orange-red; sides of carapace pale grayish-olive." These are colors found to prevail in *C. carolinus*.<sup>59</sup> More information about this red phase is desired, and it should be pointed out that, morphologically, these red specimens approach most closely the eastern form (see above).

My largest male (I) from Tennessee (Athens) is 62 mm., long; the largest male (II) (Clifty) is 76 mm.; and the largest female (Fountain City) is 104 mm.

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<sup>59</sup>A red specimen of *C. diogenes* has previously been found at Dunbar, Fayette Co., Pennsylvania, among normal ones (Ortmann, '06, p. 410).

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